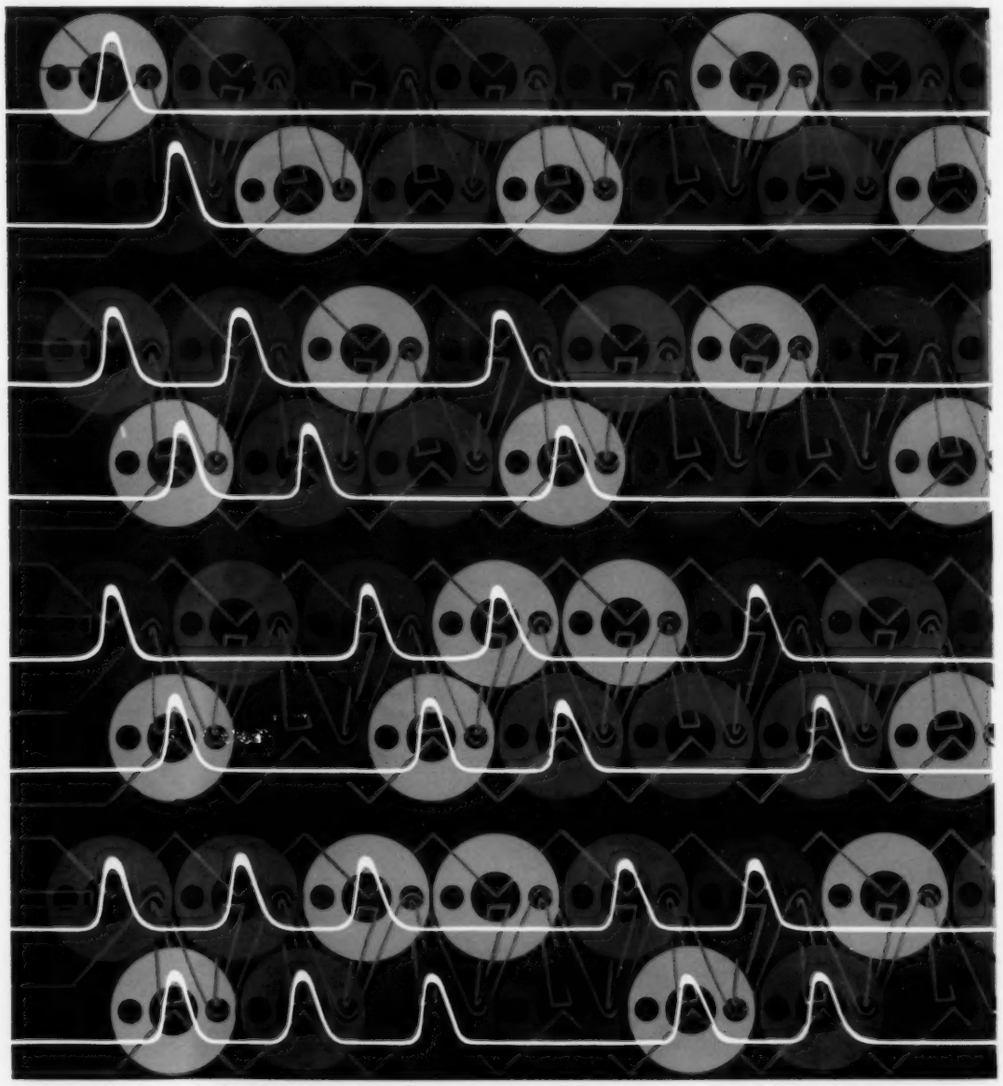
MILITARY SYSTEMS DESIGN

MARCH-APRIL 1961



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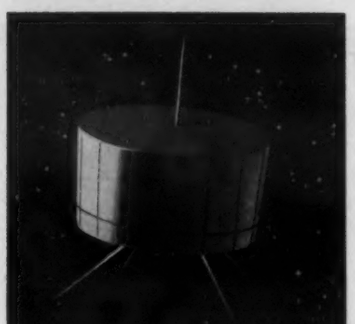

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COVER: Logic systems, as symbolized by the artist's conception of a magnetic core shift register, are essential in any digital computer. Certain advantages of the multiaperture magnetic core over other logic elements are described in the article beginning on page 4.

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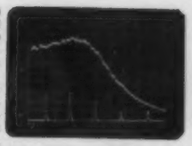

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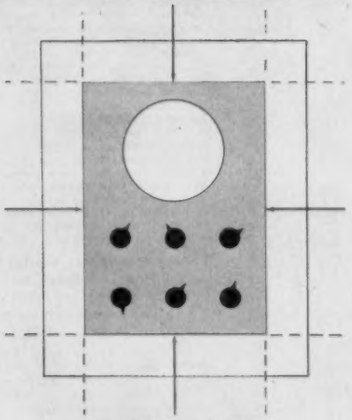

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M.S.D. EDITORIAL

Political

"I know no safe depository of the ultimate powers of society but the people themselves; and if we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion by education."—From a letter by Thomas Jefferson, 28 September 1820.

Probable reaction of the American economy to national problems, including overproduction, unemployment and defense expenditures, and to government initiated measures for their solution will be hotly debated in every public forum during the months ahead. Honest and informed men will look at the same data and arrive at drastically opposed solutions. When leadership is so divided failure to take any action is understandable. However, this absence of action is no more an effective solution for the "ship of state" than it is for a ship in a storm at sea.

Differences of opinion exist in any complex area of endeavor, including the design of airfoils and inertial guidance systems. However, in the physical sciences, hypotheses are not resolved by debate, but by actual trial, by the testing of scale models, or by statistical simulation using computer techniques.

In economic and political actions involving persons and governments an ill-advised actual trial is sometimes disastrous—as witness the Congo today. Also, "wind tunnel techniques" provided by voter reactions to Congressional speeches or to debates between presidential candidates do not reliably predict reactions of the national economy. However, *digital computer simulation*, by discovering and displaying statistical relationships between economic forces may now offer, for the first time in history, a tool which could be used to resolve many controversial questions of economic cause and effect.

Such a machine might take the form of a giant computer capable of collating a great number of variable inputs to simulate the interplay of commodities, credits, labor and other services, taxes and capital investment which continually takes place in any major sector of our economy. The methods would be similar to, but more extensive, than those used in "War Games" or "Management

"Wind Tunnel" vs Statistical Simulation

Games" in which computers are used to work out the probable outcomes of certain choices and actions made by the players.

The intelligent use of such simulation should remove many questions of economic method from the area of public debate. Specific proposed actions would be programmed on the simulator while the system parameters were varied to show probable results of the hypothetical action on various sectors of the economy.

A brief survey of authorities in the computer field shows that this idea is not particularly new. In fact, *econometric simulations* without benefit of electronic computers go back to the work of the Cowles Commission in the '30's and 40's, to Ragnar Frisch in Norway, Tinbergen in the Netherlands, and others. Shortly after World War II, experimentation using early computers with the so-called Leontief[1] input-output models of the economy was sponsored by a Federal Agency. The funds for this early attempt in computer simulation were cut back in 1954.

This use of computers is quite within the present capability of the art, according to Dr. Morris Rubinoff, of the Moore School of Electrical Engineering, University of Pennsylvania. He cautions that prediction theory has certain limitations when applied to non-stationary time series; also that a difficulty in obtaining input data would probably arise, since a great deal of information underlying economic and politico-economic decisions is "either classified, personally confidential or just intuitively subjective."

In answer to our question, "Is such an application now feasible with any existing computer," Mr. Howard K. Janis, of the International Business Machines Corporation, says that so broad an application as is suggested here is not presently feasible because the necessary systems programming techniques are not yet known. He adds that it may be possible to define less sophisticated economic problems that could be solved now, using fewer variables.

In estimating how soon a computer could be built capable of simulating a major sector of the nation's economy, Mr. Janis answers: "If by the 'present state of computer art' you mean technology, it is not yet clear whether there is a great problem in technology here. A tremendous effort in *systems programming* is necessary to achieve the kind of results you call for. Just when a computer is capable of simulating a major sector of the nation's economy will depend on how soon this systems programming effort gets under way and how much emphasis is put on it. The problem is largely one of 'software' rather than of 'hardware.' Existing computers could certainly be used as tools to develop statistics and inter-relationships that would define the economic problem."

In short, the crux of the question is, do we have the ability to use our computers? According to the experts, we have—or can readily develop—the mechanics and circuitry. We lack agreement, at present, on what data to use, what relationships to test, what questions to ask. Basic research in economic simulation is needed.

The contribution to be made by the computer simulation technique must be kept in proper perspective. It is a tool, not an oracle. How successful it may prove, as the experts have stated, must await study, evaluation and, probably, a period of evolution. However, since a technique of simulation of the scope needed to deal with economic problems on the national scale is not likely to be evolved as a by-product of any other problem of research, we believe that the Federal government should recognize that further sponsorship of study in this field is urgently needed.

Even a partial success of such an effort should contribute to our present uncertain understanding of economic interrelationships in the peculiar combination of private enterprise and of public-owned, government-aided, and government-operated businesses that in total comprise the "American System."

We believe that Thomas Jefferson's trust is basically as sound in 1961 as it was in 1820. Our elected representatives—"with their discretion informed by education"—can be trusted in the "exercise of their control." Our modern world is tightly coordinated and its problems complex. The fact-finding mechanisms available to those in positions of responsibility can be considerably improved.

[1]"Input-Output Economics," Wassily W. Leontief, *Scientific American*, October 1951.

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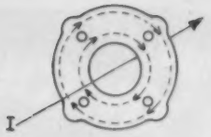


FIG. 1. AMP-MAD ferrite core in zero ("0") state.

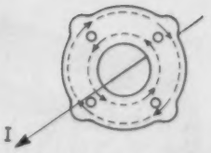


FIG. 2. "SET" condition, core in one ("1") state.

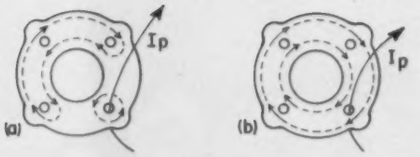


FIG. 3. PRIME current through minor aperture reverses flux around minor aperture in "set" core (a), has no effect on "clear" core (b).

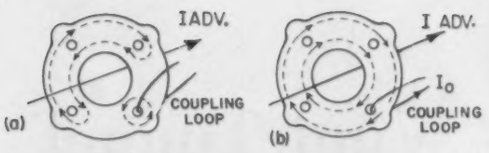


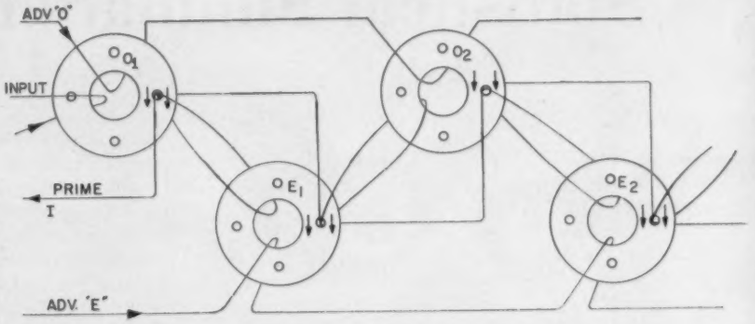
FIG. 4. ADVANCE pulse through primed core (a) reestablishes 0 state as in (b), giving strong output signal (I_o).

An Introduction to

All-Magnetic Logic

by J. S. BOWEN

The author is Product Sales Manager, Magnetic Devices Div., AMP Incorporated.



FLUX ORIENTATION AROUND TRANSMITTING MINOR APERTURES

PULSE SEQUENCE	CORE O_1	CORE E_1	CORE O_2	CORE E_2
REST	↓o↓	↓o↓	↓o↓	↓o↓
SET	↑o↓	↓o↓	↓o↓	↓o↓
PRIME	↓o↑	↓o↓	↓o↓	↓o↓
ADV. O	↓o↓	↑o↓	↓o↓	↓o↓
PRIME	↓o↓	↓o↑	↓o↓	↓o↓
ADV. E	↓o↓	↓o↓	↑o↓	↓o↓

FIG. 5. "O" and "E" CORES for each bit are combined in a shift register. All cores are illustrated in the "Rest" position. Flux around transmitting minor aperatures after successive pulses are shown in table.

The inherent advantages in using magnetic materials, including ferrite cores, in digital memory have long been accepted. Digital logic is a new field in which ferrite cores also can be used to advantage. With this as a goal, AMP Incorporated of Harrisburg, Pennsylvania, has developed a series of logic packages, beginning with all-magnetic shift registers.

The basic feature of the ferrite core element is that flux paths of different direction can exist in the same core. These flux patterns are set up by momentary current pulses and persist until changed (due to magnetism).

Fig. 1 shows a core in the "Rest" or "Clear" condition with flux established in the clockwise direction with respect to the major apertures, because of a previous current in a wire threading the major core aperture (this wire is called the advance circuit wire). When the core flux is in this pattern it is in the "0" (or clear) state.

If current of *smaller magnitude* and a reverse direction is next applied through the major aperture, as in Fig. 2, the core will have flux in the counterclockwise direction around its inner periphery, while the flux direction around its outer periphery remains in the clockwise direction. (In the actual element, a separate wire, called an input wire is used for this current). When the flux is in this condition, the core pattern is in the "1" (or set) state. Note that essentially, a clockwise flux loop is set up around each minor aperture.

For "reading" the state of the core, two techniques can be used, one destructive and one nondestructive. The destructive readout, which is used for shifting, as in shift registers, is performed as follows:

A controlled current pulse (called a "prime" current) is applied through one of the minor apertures, as shown in Fig. 3. If the core had been in the 1 state, the flux in the core will then be as shown in Fig. 3A; the prime current establishing a minor flux loop *counterclockwise* around this minor aperture. In other words, the flux around this minor aperture has been reversed, with the flux patterns around the other minor apertures remaining in the set or 1 state.

If the core is in the 0 state (as in Fig. 1) three times as much current is required to establish a minor loop of flux around the prime wire. In other words, if this large current is not used, no minor loop results. Thus a minor loop results around a "primed" minor aperture only when the core has previously been in the 1 state.

For the destructive readout operation, a driving current pulse with short rise time is applied to the advance wire, as in Fig. 4. This current reestablishes the "clear" state flux paths as in Fig. 1, and in so doing, causes the flux around the minor aperture to change. This change in flux induces a signal in the coupling loop shown in Fig. 4. This output signal is strong enough to serve as in input signal to another core, to set it into the 1 state. Hence a 1 state in one core can switch a second core from 0 to the 1 state without intermediate amplification. This is the shift function.

Considering the flux distribution in the "clear" core in Fig. 4B, it can be seen that when the driving pulse is applied to the major aperture of this core, no remanent flux will be switched under the coupling loop and, therefore, no signal is transmitted through the coupling loop to the following core. In this manner, a 0 is effectively transmitted from one core to another.

Shift-Register Operation

The switching technique now can be projected into a wired array to form a shift-register package. Such shift registers utilize a two-core per bit and a two-clock pulse scheme to achieve shifting through each bit location. Fig. 5 shows flux distribu-

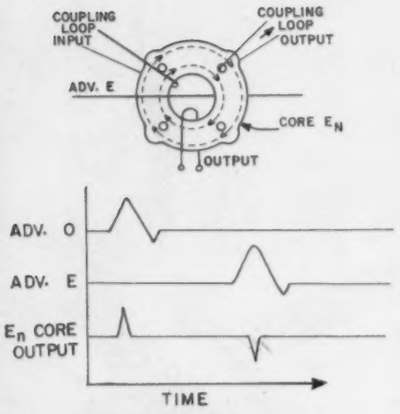


FIG. 6. DYNAMIC OUTPUTS of E_n core are bipolar.

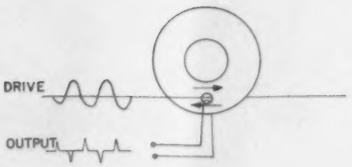


FIG. 7. STATIC OUTPUT is non-destructive. When sinusoidal drive is applied to "set" core, ac output results; applied to "clear" core, no output.

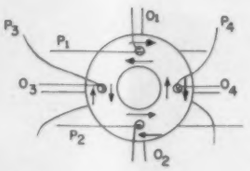


FIG. 8. MULTIPLE outputs from each core, with each minor aperature under direction from separate priming circuit, can be obtained.

tion within the cores with respect to the timed sequence of application of the driving pulses. In the rest position, all cores in the array are in the "clear" sense. Since in shift register applications we are concerned only with flux distribution around the transmitting minor aperture (the aperture containing the coupling loop and prime circuit), only the changes in remanent flux orientation due to the applied pulses are shown.

When a 1 pulse is set on the input terminals to core 0_1, the inner leg of the transmitting minor aperture is placed in the "set" sense. Since no other cores are threaded by this input winding, and since the setting of the core switches no flux under the coupling loop, there are no other flux changes within the array.

Applying a "prime" current to the array reverses the flux locally around the transmitting minor aperture of core 0_1 but affects no other cores because the level of the prime current is held below the minor/major aperture threshold. Also, because of the low prime-current amplitude and polarity, this rotation of flux around the transmitting minor aperture does not induce a harmful signal in the coupling loop.

Next, the application of pulse advance 0 drives the flux in the outer leg of core 0_1 to the "clear" state with a high rate of change of flux. This induces a sufficient signal in the coupling loop to set core E_1, leaving core 0_1 in the "clear" state. The prime current then rotates the flux locally around the transmitting minor aperture core E_1. The application of pulse advance E then drives the outer leg of core E_1 to the "clear" state, again inducing a sufficient signal in the coupling loop to set core 0_2. It is now evident that the application of pulses in this sequence can provide a shift of a "1" through one bit location of a shift register.

Sequentially applying prime, advance 0, prime, and advance E pulses will shift the information further down the register. It is important to notice that after each advance E pulse, all information in the register is stored in the 0 cores; also that new information may be serially fed into the shift register via the input loop at any time following the advance 0 pulse and prior to the prime current pulse preceding the next advance 0 pulse.

Dynamic and Static Output

Two types of outputs are available from the AMP-MAD® shift register; a dynamic output available only when the register is shifting, and a static output available when the register is not shifting. In Fig. 6 the dynamic output, taken from the E core, has a bipolar output available because flux is switched under the output windings both when the core is receiving (on the advance 0 pulse) and when transmitting (on the advance "E" pulse). The amplitude of this dynamic output can be 20 v or greater. Fig. 6 shows the output for the transmission for a 1. Since no remanent flux is switched during the transmission of a 0, the 0 output would be approximately one order of magnitude less than that for a 1. In the transmission of a 0 elastic flux only is switched.

Non-destructive readout of an AMP-MAD core is illustrated in Fig. 7 which shows one method of driving a set core to produce a non-destructive static output of the information content of a register. If a sinusoidal drive is applied to the minor aperture of a "set" core, flux around the minor aperture will be switched locally to provide a continuous output from the core. Again, if the core is in a "clear" state, no remanent flux is switched by the driving pulse. Depending on core materials and drive parameters, static power outputs from "set" cores in excess of 125 milliwatts can be obtained.

Multiple Outputs

A further extension of the core-to-core transmission technique used within the AMP-MAD shift register is indicated in Fig. 8. Considering a core that has been set, it can be seen that if an advance pulse is applied to the core no outputs will be present on lines 0_1 through 0_4 inclusive unless the corresponding minor aperture has been primed. As-

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PANORAMIC PERSPECTIVE

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20mm f/1.9*	75mm f/2
25mm f/2	100mm f/2
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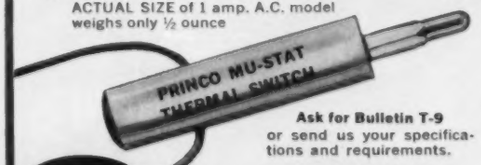

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• Diameter	⅞"
• Length	1.55" (Bushing) 1.611 (Servo)
• Maximum Resistance	100,000 ohms
• Indep. Linearity	± .25%, To ± .05%
• Wattage	4.5 watts @ 40°C.
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• Maximum Torque	1.0 oz. in.
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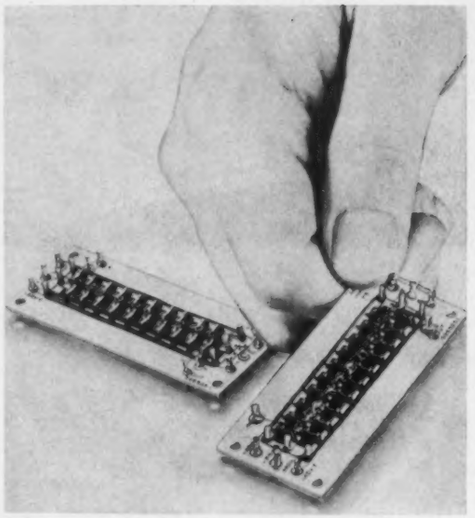


FIG. 9. 10-BIT SHIFT REGISTER is rugged unit having no contacts or moving parts and capable of withstanding high radiation levels.

suming that one minor aperture and prime line is used for conventional shifting functions, on command a prewired unit can be directed (by priming additional apertures) to shift its information into additional channels without altering the information content of the unit or destroying its ability to function normally. Therefore, in a "set" core, it can be seen that a signal appears in a coupling loop when an advance pulse is applied *only* if the minor aperture threaded by that coupling loop has been primed.

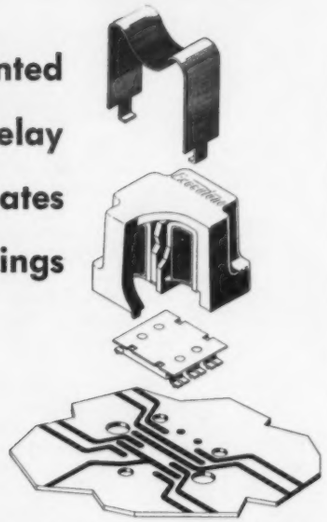
The above-described core-to-core transmission techniques are basic to the logic packages developed by AMP INCORPORATED. In other articles to follow specific discussions concerning gating elements will be provided. All such elements use cores and driving pulses identical with those required to operate the shift register, eliminating the need for complex interface or buffering circuits (Fig. 9).

In addition to the inherent advantages of magnetic logic such as reliability, package size, elimination of sustaining power, and ability to withstand high radiation levels, there also appear to be interesting advantages in the systems applications of magnetic logic. Preliminary investigations indicate that specific logic functions may prove to be more practical and more easily obtained in all-magnetic systems than in present methods wherein combinations of logic techniques are used to obtain the desired end result.

The circuits and arrangement disclosed herein may be covered by patents of AMP INCORPORATED or others. Neither the disclosure of any information herein nor the sale of shift registers or drivers by AMP INCORPORATED conveys any license under patent claims covering combination of shift registers and drivers with other elements. In the absence of express written agreement to the contrary, AMP INCORPORATED assumes no liability for patent infringement arising out of or in connection with any use of the circuits described or implied herein.

FOR MORE INFORMATION CIRCLE 121 ON READER-SERVICE CARD

Printed Contact Relay Eliminates Springs



A space-saving new printed contact permanent magnet relay, known as Printact®, is mounted on and becomes an integral part of a printed circuit board. Fixed contacts are eliminated entirely and the moving contacts which are part of the armature assembly are designed to mate with conductors on the printed board. A ceramic permanent magnet is used in place of a spring to hold the relay armature open. This force remains constant and eliminates any adjustment or maintenance.

The relay is accurately positioned on the printed circuit board by studs which pass through punched holes in the board. It is held in position by a simple spring. Only the coil terminals require soldering. Contact layouts to accommodate single-, two- and three-poles in single- and double-throw configurations can be used by the customer.

The magnetic motor assembly is moulded in a high-impact plastic. The ceramic biasing magnet is positioned between two U-shaped pole pieces made of No. 5 relay steel. The pole pieces are assmbled with the magnet between them to form an E-shaped structure with the coil surrounding the center leg.

The armature is normally biased against one leg of the E by the permanent magnet. When voltage is applied, the flux produced by the coil tends to attract the other end of the armature across the open air gap, at the same time bucking the flux of the permanent magnet and tending to cancel the attractive force across the closed gap. Sufficient current through the coil will cause the armature to rotate; removal of this current permits the permanent magnet to restore the armature to its first position.

The use of a permanent magnet, whose restoring force tends to decrease rather than increase as the armature rotates, accounts for the high (300 milliwatt) sensitivity and enhances the snap action of the relay compared to a conventional relay with a return spring. Coils for 6, 12 and 24 v dc are standard. Recommended printed-circuit methods provide contact current capacities to 2 amp.

®Printact is a patented development of Executone, Inc., of 47-37 Austell Place, Long Island City 1, N. Y.

FOR MORE INFORMATION CIRCLE 122 ON READER-SERVICE CARD

VITRAMON, INC. *Develops Dramatically Improved Dielectric Material*

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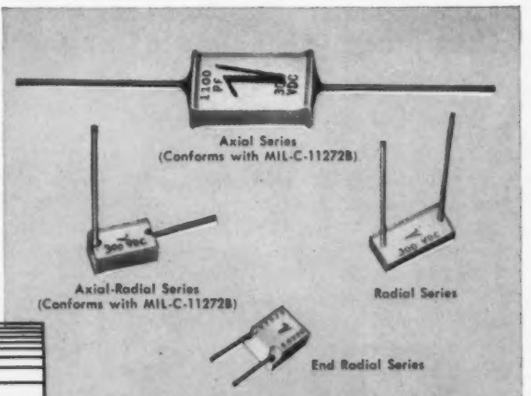

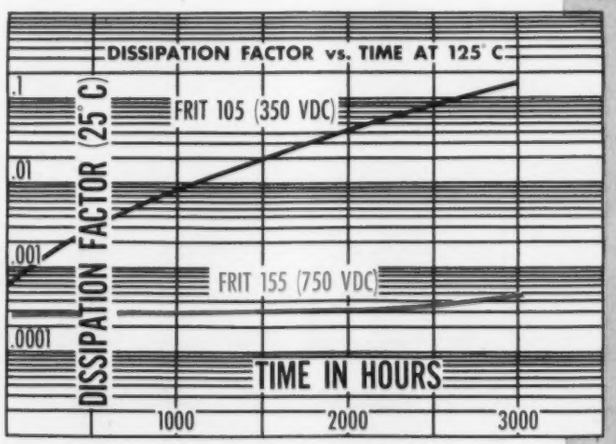

When tested at 125°C with more than twice previous test voltages applied (750 VDC vs 350 VDC and 450 VDC vs 200 VDC) and with the time extended to 2000 hours (more than 10 times as stringent a test) post-test dissipation factor is .002 max. and insulation resistance is greater than 100,000 megohms (10 times better)!

NOTE: Offered Exclusively For **MIL-C-11272B** Requirements.

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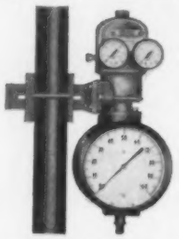

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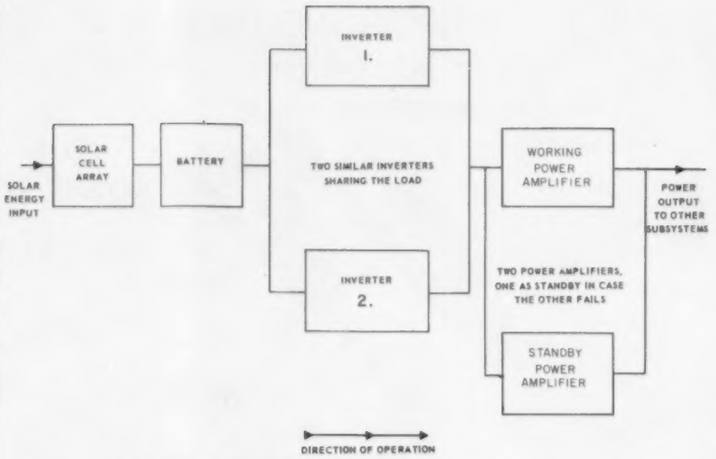

FIG. 1. CHAIN OF EVENTS for the operation of a satellite power supply system.

Reliability Evaluation of a Satellite Power-Supply System

by ***F. LEMUS*** Air Defense Technical Center, SHAPE, The Hague.*

Evaluation of the reliability of a moderately complex system in terms of average-time-to-failure and the probability of its specified operation for a specified minimum time is discussed for a sun-powered satellite power supply system. The method is applicable to other complex engineering systems.

***Prior to 1 February 1961, the author was a member of the Lockheed Missiles and Space Division, Sunnyvale, Calif.**

The average-time-to-failure of any system depends on the relative position of its various subsystems. Some are in series with each other so that a failure of one subsystem results in a failure of the whole system because it breaks the chain of events required for successful operation. Other subsystems are in parallel with each other; they either share the load among themselves (active redundancy), or carry the load independently while others stand by when active redundancy fails (stand-by redundancy).

The steps in the reliability evaluation are:

1. Divide the system into its various component parts (or subsystems).
2. Determine whether each subsytem is in series or parallel (active or standby redundancy).
3. Measure the mean-time-to-failure for each subsystem (in test laboratory).
4. Obtain the mean-time-to-failure and reliability of the system by use of appropriate formulas from Table 2.

The satellite power-supply system on which a reliability figure is required consists of four subsystems of component parts (Fig. 1). These, in the order of their operation are (1) the cell array which takes energy from the sun, (2) a battery which supplies constant power, (3) two inverters sharing the total load, and (4) a power amplifier to step up the signal.

The four subsystems are each essential to the operation of the power-supply system because the failure of one of these major components would result in a lack of power for the whole system. For this reason they are considered to be in series with each other. On the other hand, the two inverters constitute a parallel arrangement because both share the total load (active redundancy), although each by itself is capable of carrying a full load.

The two amplifiers are in a parallel arrangement of a slightly different type. One amplifier is used as a stand-by for the other in case of failure (standby redundancy). A failure-free switch transfers the load from the failed amplifier to the standby.

The problem consists in finding the average-time-to-failure and the reliability of the system. *Reliability* is the probability of successful operation of the complete power-supply system for any specified minimum time, when the average-time-to-failure for each of the subsystems has been established

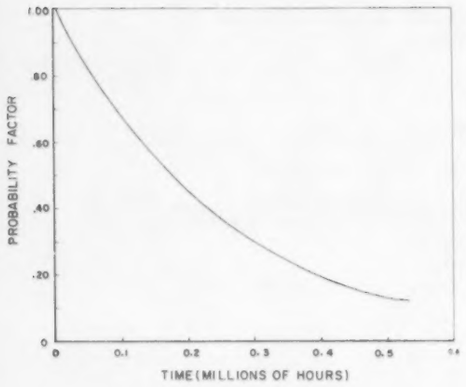

FIG. 2. PROBABILITY of successful operation of power supply for any specified time "t".

TABLE 1. FAILURE RATES OF SUBSYSTEMS IN SATELLITE POWER-SUPPLY

Component	Average Failure Rate (Failures per million hours)	Mean-Time-to-Failure (Average number of hours between failures)
Solar-Cell Array	$F_1 = 1.6$	$T_1 = 625{,}000$
Battery	$F_2 = 1.8$	$T_2 = 555{,}000$
Inverter	$F_3 = 0.4$	$T_3 = 2{,}500{,}000$
Power Amplifier	$F_4 = 0.5$	$T_4 = 2{,}000{,}000$

by laboratory tests.

Laboratory tests are used to establish for each of the subsystems a total time of operation and the total number of failures. Then the *failure rate*, (F), or number of failures per unit time, is computed as follows:

$$F = \frac{\text{total number of failures}}{\text{total time of operation}}$$

The total time of operation for each subsystem must be selected so that it extends beyond the preliminary, or debugging stage, where failures due to imperfections in manufacture and assembly are more common. On the other hand, the time of operation should not be extended into the "wear-out" stage, where the number of failures increase with added periods of operation. The average failure rates for each subsystem of Fig. 1 are shown in Table 1. To be statistically reliable, this means that a substantial number of units of each subsystem must be tested.

The failure rate or number of failures per million hours is the inverse of the average time of failure-free operation. Thus a failure rate of two failures per million hours represents an average time of failure free operation of 500,000 hours.

The average failure rate for a system composed of a number of subsystems in series is found by adding the failure rates for the separate subsystems. Failure rates for components in *parallel* are computed according to formulas in Table 2. Thus,

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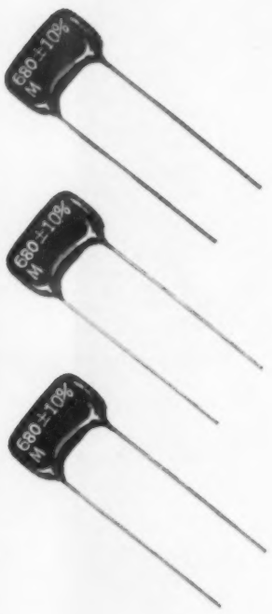

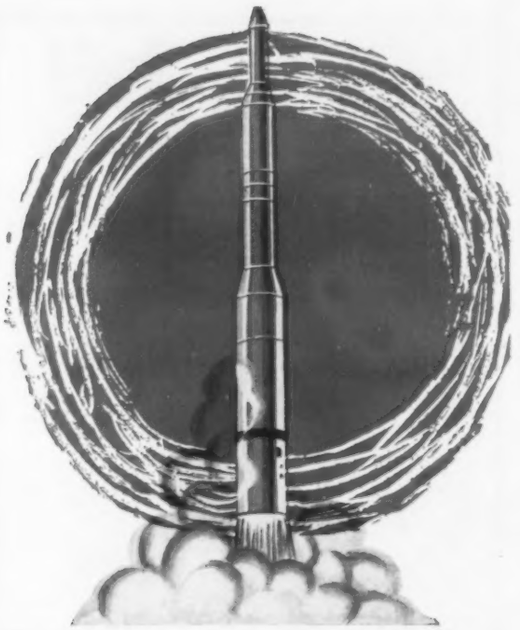

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Ten thousand El-Menco high reliability dipped mica capacitors were put on life test at 85°C with 225% of the rated DC voltage applied in accordance with an RCA high reliability specification.

*After 22,000,000 actual test unit-hours no**failures of any type occurred*

The accumulated 22 x 10^6 test unit-hours without any failures can be used to calculate many different failure rates depending upon the confidence level desired. However, we shall explore the meaning of the results at a 90% confidence level.

Assuming no acceleration factor for either temperature or voltage, we have verified a failure rate of approximately .01% per 1000 hours. (Actually, there is a temperature effect and it has been found that, with the DC voltage stress remaining constant, the life decreases approximately 50% for every 10°C rise in temperature. There is also a voltage effect such that, with the temperature stress remaining constant, the life is inversely proportional to the 8th power of the applied DC voltage.)

Assuming no temperature acceleration factor and assuming the voltage acceleration exponent is such as to yield an acceleration factor as low as 100, we have nevertheless verified a failure rate of approximately .0001% per 1000 hours.

Assuming no temperature acceleration factor and assuming the voltage acceleration factor is on the order of 250 (test results are available to confirm this) we have accumulated sufficient unit-hours to verify a failure rate of less than 00005% per 1000 hours!

Note that all the above failure rates are calculated at a 90% confidence level!

**The El-Menco high reliability dipped mica capacitors are being supplied to the Radio Corporation of America for a high reliability military ground electronics project.*

**A failure was defined as follows:

1. A short or open circuited capacitor occurring during life test.
2. A part whose capacitance changed more than ±2% and whose capacitance did not fall within the original tolerance of ±5%.
3. A part whose final dissipation factor exceeded .002 .
4. A part whose final insulation resistance measured less than 100,000 megohms.

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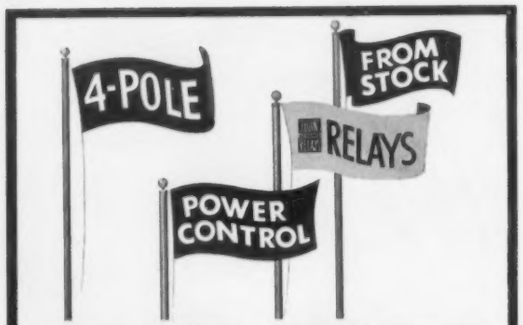

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The PC Series features heavy load carrying capacity, combined with small size — a variety of contact arrangements — and a wide range of AC and DC coil voltages and resistances.

SPECIFICATIONS

Contact arrangements – SPDT, DPDT, 3PDT, 4PDT
Contact rating – 15 amps resistive, 5 amps inductive
Contact material – 0.25" dia fine silver
Coil voltages & resistances – wide range of AC and DC
AC power – 10-12 VA, nominal
DC power – 2-3 watts, nominal
Dimensions – 1.906" x 3.062" x 2.593", maximum
Weight – 8 ounces, maximum

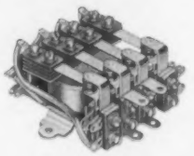

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TABLE 2. FORMULAS FOR MEAN-TIME* AND RELIABILITY OF "n" SIMILAR COMPONENTS

Relative Position	Mean-Time-to-Failure of the Combination (M_c)**	Reliability of the Combination [R(t)]**
n components in series	$M_c = 1/(1/M + \dots 1/M) = M/n$	$R(t) = e^{-(n/M)t}$
n components in parallel (sharing the load)	$M_c = M\left(1 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{n}\right)$	$R(t) = \sum_{i=1}^{n} \delta_i \binom{n}{i} e^{-it/M}$ $\delta_i = +1$, if i is odd $\delta_i = -1$, if i is even
n components in parallel (one component withstands the load, while the remaining n-1 stands by in case of failure)	$M_c = M + M + M + \dots + M = nM$	$R(t) = e^{-\frac{t}{M}} \sum_{i=0}^{n-1} \frac{1}{i!}\left(\frac{t}{M}\right)^i$

*The mean-time-to-failure of each of the n components equals M.

**These formulas may be expressed in terms of failure rates by replacing $\frac{1}{M}$ with F.

for the system in Fig. 1:

$$F_1 + F_2 + \tfrac{3}{5}F_3 + \tfrac{1}{2}F_4 = 1.6 + 1.8 + 0.27 + 0.25 = 3.92$$

failures per 10^6 hours,

The mean-time-to-failure is 255,000 hours.

Finally, the reliability (probability of successful operation for the entire power supply system) is shown in Fig. 2, which is a graphical representation of the following formula:

$$R(t) = (e^{-4.3\times10^{-6}t})(2 - e^{-0.4\times10^{-6}t})(1 + 0.5\times10^{-6}t)$$

The derivation of this formula is based on the assumption, borne out by experimental evidence, that the exponential distribution function generally represents the deterioration of equipment.

Derivation of Reliability Formulae

Time-to-failure is assumed to be exponentially distributed:

$$f(t) = Fe^{-Ft} \quad 0 < t < \infty$$

By definition, *reliability* is the probability that the equipment will last t hours or longer; thus:

$$R(t) = \text{reliability} = \int_t^\infty Fe^{-Ft}\,dt = e^{-Ft}$$

By definition, the *average* time-to-failure, or E(t), is

$$E(t) = \int_0^\infty t\,f(t)\,dt = \int_0^\infty tFe^{-Ft}\,dt = 1/F$$

Reliability of a series of n components

$$R(t) = e^{-nFt}$$

The *average* time-to-failure is

$$E(t) = \int_t^\infty tnFe^{-nFt}\,dt = nF$$

Reliability of n items in parallel, where n−1 of these items are on a stand-by basis

For the particular case n = 2,

$$R(t) = R_1 + P_1R_2$$

where

R_1 = probability component No. 1 operates satisfactorily from time t to time ∞.

P_1 = probability that component 1 fails from time 0 to time t

R_2 = probability that component 2 operates satisfactorily from time $(t - t_1)$ to time ∞ .

Thus:

$$R(t) = \int_t^\infty f(t)\,dt + \int_0^t f(t_1)\left[\int_{t-t_1}^\infty f(t)\,dt\right]dt_1$$

$$R(t) = e^{-Ft}(1 + Ft)$$

and $E(t) = 2/m$

In general, for n items in standby parallel the reliability function is

$$R(t) = e^{-Ft}[1 + (Ft)/1! \dots (Ft)^n/n!]$$

and $E(t) = n/F$

Reliability of n components which share the total load, although each component is capable of carrying the whole load

For the particular case n = 2, success is achieved in any one of three exclusive ways, each of which is expressed as a term in the sum below:

R(t) = (Prob. component 1 succeeds) (Prob. component 2 fails)
+ (Prob. component 2 succeeds) (Prob. component 1 fails)
+ (Prob. component 1 succeeds) (Prob. component 2 succeeds)

As shown in the above formula, the sum of these products is equal to the reliability of the over-all system; thus:

$$R(t) = 2e^{-Ft} - e^{-2Ft}$$

$$E(t) = F + F/2 = 3F/2$$

In general, for n components, (in active-parallel)

$$R(t) = \sum_{i=1}^{n} \delta_i \binom{n}{i} e^{-Fit}$$

Where $\delta_i = +1$, if n is odd

$\delta_i = -1$, if n is even, and

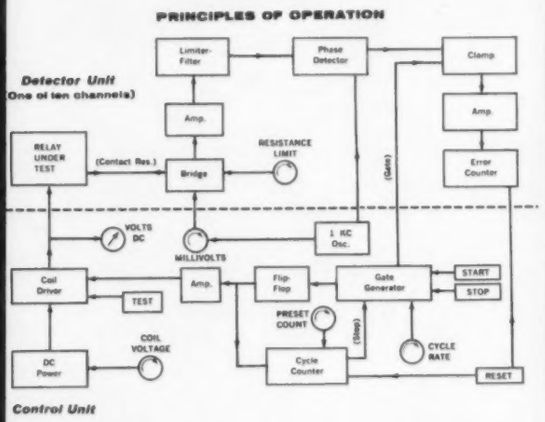
$$E(t) = \frac{1}{F}\left(1 + \frac{1}{2} + \frac{1}{3} \dots \frac{1}{n}\right)$$

Relay Dry Circuit Test Set

New Model 927 Relay Test Set, accommodating up to ten relays of a uniform type, can be set to automatically cycle the relays under test continuously or to stop at 100, 1000, 5000 or 10,000 operations.

The cycling may be stopped manually during any part of a preset run. Four Dekatron counter tubes display the total number of relay operations for a given test with a total count capacity of 9,999.

The open circuit contact voltage to the contacts



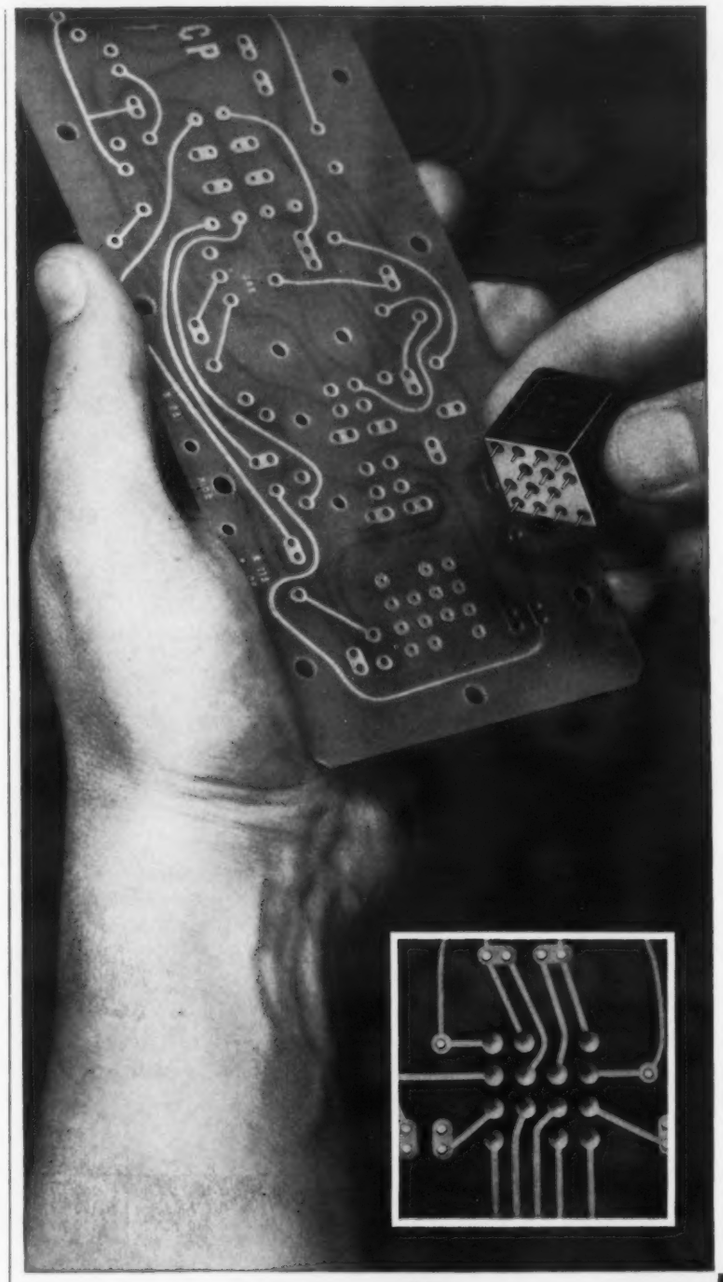
under test is derived from a 1,000 cps test signal and is continuously variable from 0.5 to 10 milli-volts, rms. The closed-circuit contact current is limited by a 500-ohm series resistor with resulting contact currents of 1 to 20 microamperes, depending on the contact voltage control setting. The voltage drop across the series-connected contacts of each relay represents the contact resistance and is compared with a stable reference voltage.

Any excessive voltage drop is detected as an error with gating circuitry provided for testing of both normally-closed and normally-open contacts while error detection during contact transfer is suppressed. The individual relay contact resistance limits are continuously adjustable for each relay under test from 50 to 500 ohms. Ten Dekatron counter tubes display the individual error counts for each of the 10 relays under test with a maximum count capacity of 9. An overflow counter indicates whether 10 or more errors have been detected and an output for auxiliary counting is provided if higher error count is desired.

The Model 927 Relay Test Set can perform an important function as a production inspection tool. The variable aspects permit a wide versatility in selecting specific levels for relays normally encountered in low-energy-level switching. By this means, it is possible to have a rapid and stable method for evaluating and inspecting production quantities of relays.

The Couch Ordnance Model 927 Relay Test Set has been designed in conjunction with the Hampshire Engineering Co., Newton, Mass. (*From 2-page V-2 Data Sheet Couch Ordnance, Inc., 3 Arlington St., North Quincy 71, Mass.*)

FOR THIS LITERATURE CIRCLE 123 ON READER-SERVICE CARD

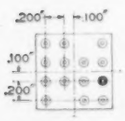


NEW Hi-G 4PDT microminiature relay

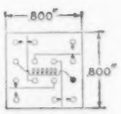
First 4-pole microminiature relay incorporating a balanced armature and featuring a pin arrangement readily adaptable to printed circuit applications. This new relay also features improved sensitivity per pole as compared with two 2-pole microminiature relays.

Type: Type 4B Microminiature
Size: .800" x .800" x .875" max.
Contacts: 4PDT dry circuit to 2 amps resistive
Dielectric Strength: 1000 VRMS at Sea Level
Insulation Resistance: 1000 megohms min.
Optional Terminals: Long or short leads for printed circuit application or hook type for standard wiring. Bracket, studs or straps also available for mounting.
Construction: Balanced armature construction, proven the best approach available for resistance to extremes of vibration and shock, exceeding all present military specifications.
Environmental Characteristics: To meet all military relay specifications for components of this size.

Printed Circuit Features



Diagram



Printed Circuit Courtesy of The Sibley Co.

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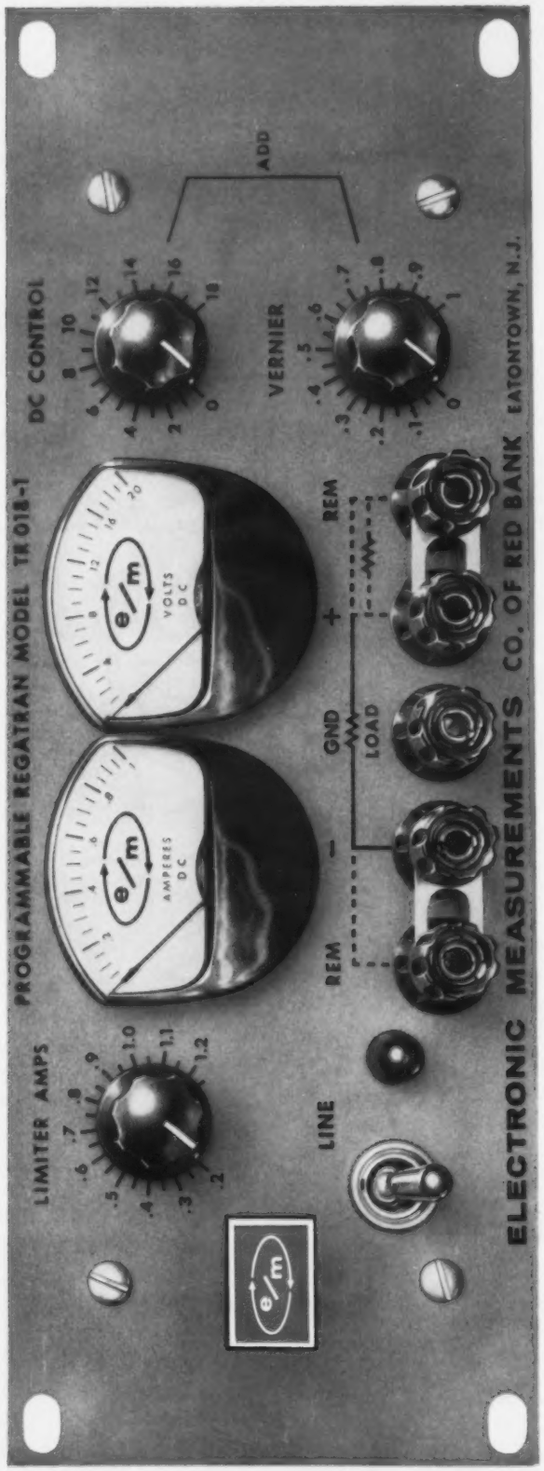

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TR036-0.2	0-36	0-200 MA	150 μv

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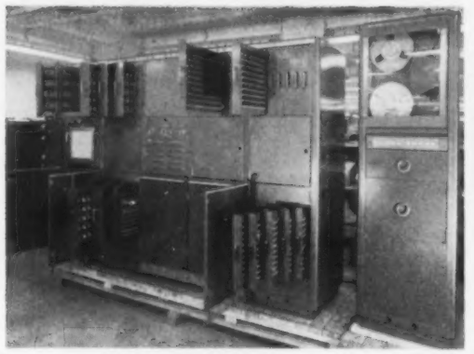

FIG. 1. X-Y PLOTTER SYSTEM for high-speed display of computed data from IBM 709 in graphic form handles up to five variables. Mounted NOR-logic modules are shown on sliding vertical racks.

X-Y Plotter Uses Logic Building Blocks

Digital computer installations often require high speed plotting of computed data. X-Y relationships, in graphic form, allow instantly clear understanding and interpretation of problem results, permitting the engineer to limit his analysis to only significant data.

A contract with the Air Research and Development Command called for the development by Radiation Incorporated, Melbourne, Fla., of a system capable of making near real time X-Y plots of up to five variables from information contained on magnetic tapes generated by an IBM 709 digital camputer.

The system plots up to five variables in a pure X-Y form, and provides automatic control features for simple and fast reduction and display, providing an unlimited number of copies of the plot. In addition, the system provides a selectable grid presentation and allows alpha-numeric print information to be placed anywhere on the plot. The arithmetic operation of $Y = 2^AX + B$ is carried out.

The X-Y plotter, with inherent digital accuracy, can plot any arbitrary geometry. Featuring overlapping annotated traces, the system has a resolution of 1 part in 512 (10.8″ x 10.8″ plot). Selection of grid scale for both X and Y axis is arbitrary and there is an X parameter inhibit for Y parameter maximum and minimum plots.

System Components and Packaging

The system consists of Radiation Incorporated designed electronic NOR logic, programming controls and power system. In addition, a Bryant revolving magnetic drum for intermediate storage of all incoming plot or print data is utilized. An Ampex FR-400 tape transport is used as an input device. The components are mounted on vertical racks contained in six Emcor cabinets. (Fig. 1).

FIG. 2. **NOR-LOGIC** modules shown are large Keyer and small basic NOR Logic modules, in both unencapsulated and finished forms.

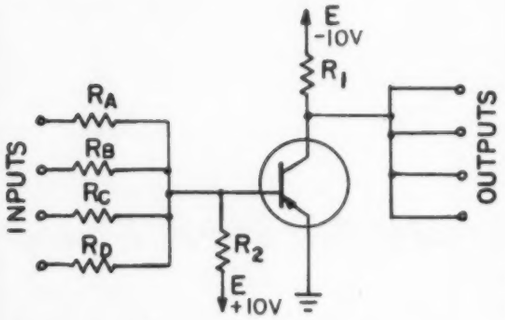

FIG. 3. **BASIC NOR** circuit uses single PNP junction transistor normally operating in cutoff condition with an output of —5 v. A pulse of proper magnitude and polarity applied to any input will switch the transistor into saturation.

NOR-logic modules, called Radilogs, serve as the basic "building blocks" around which the overall plotter system was designed (Fig. 2). Three basic types of modules accomplish the necessary logic functions. These are the NOR, the DIFFERENTIATOR and the POWER DRIVER. Each of these elements is packaged in three separate modules encompassing three different speed ranges, comprising an entire range of rugged, color-coded, encapsulated Radilog modules for use in conventional 9-pin tube sockets.

A single transistor element inherently performs NOR logic (Fig. 3). The NOR element can be operated in such a way that it performs the three basic functions AND, OR and NOT. Since the element performs the DeMorgan inversion directly, it is a powerful tool for logic.

The Radilog family of modules were developed to fill the need for universal standard modules, applying the axiom that "the smallest incremental form of standardization provides the maximum utility."

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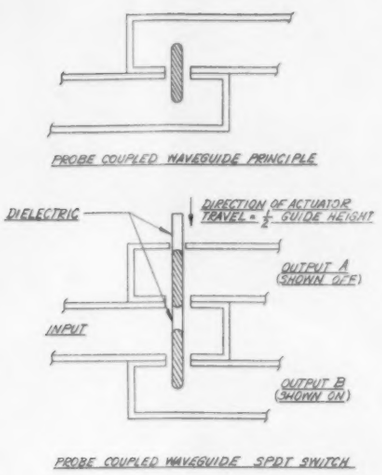

FIG. 1. COAXIAL PROBE principle (top) is heart of new lightweight switch (bottom) which simplifies complex RF waveguide switching applications.

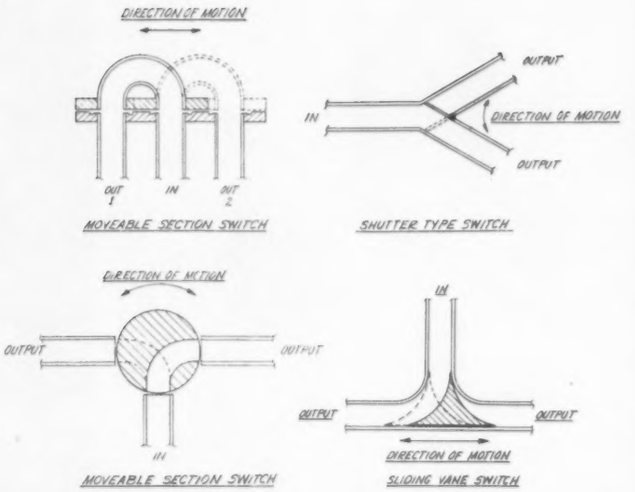

FIG. 2. CONVENTIONAL RF SWITCHES utilize large moveable masses, require inflexible configurations or use mechanical contacts.

New Waveguide Switch Uses

A new waveguide switch, developed by Transco Products, Inc., Los Angeles, utilizes the coaxial principle for coupling waveguides. This principle is used widely for transitions and rotary joints, but this is the first known application for waveguide switching. The switch will be marketed under the trade name, *Transprobe.*

The Transprobe switches RF energy between waveguides by the movement of a small, lightweight, dielectrically supported metal probe actuated by a plunger-type solenoid. This design (Fig. 1) can be adapted to any waveguide size and offers a number of advantages over conventional guide switches.

Conventional moveable section switches (Fig. 2) are large in size and weight, and the large mass that must be moved limits the life and slows the switching time. Required actuator power is relatively high. Shutter type switches have inflexible flange positions and the mechanical contact of the moveable shutter limits life and limits ability to obtain minimum crosstalk.

Transprobe switches are small and light; ideal for airborne applications. For example: An X-Band SPDT switch for RG-52/U (Fig. 3) requires only the space for 3 wave-guides plus the solenoid (1″ dia. x 1-3/4″) weighs 6 oz.

Extreme flexibility is provided by positioning the waveguide flanges at any angle in 360° around the probe. The design can be readily packaged for SPDT, SP3T, multipole, double pole transfer, and crosspole transfer applications, which include many lightweight configurations not previously feasible.

The solenoid plunger and a small probe are the only moving parts in the Transprobe, so the operating life is extended far in excess of more complicated mechanical switches. The solenoid is similar in design to those qualified for 2,000,000 operations. There are no points of electrical RF

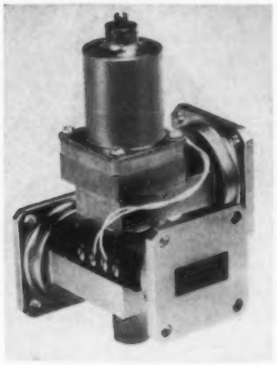

FIG. 3. X-BAND SPDT
Transprobe waveguide switch for RG-52/U operates under full waveguide power of 250 kw peak power, 160 watts average power, in less than 10 msec switching time.

Co-Ax Probe

contact, therefore, repeated operations do not degrade performance.

The X-Band SPDT Transprobe is actuated with 20 only watts max compared with over 100 watts for other switches. This design uses one plunger-type solenoid which requires holding power in one position only and provides a fail-safe position when no power is applied.

Typical performance specifications for the SPDT X-Band switch are:

Frequency	8.2 - 12.4 kmc
VSWR	1.20 max.
Insertion Loss	0.20 db max.
Crosstalk	50 db min.
Weight	6 oz.
Actuator Power	20 watts

The design is particulary well adapted to airborne and missile applications where size, weight, and actuator power are prime considerations. Present applications and proposals include airborne ECM and time-sharing of ground radar antennas. Switches can be MIL-Spec qualified.

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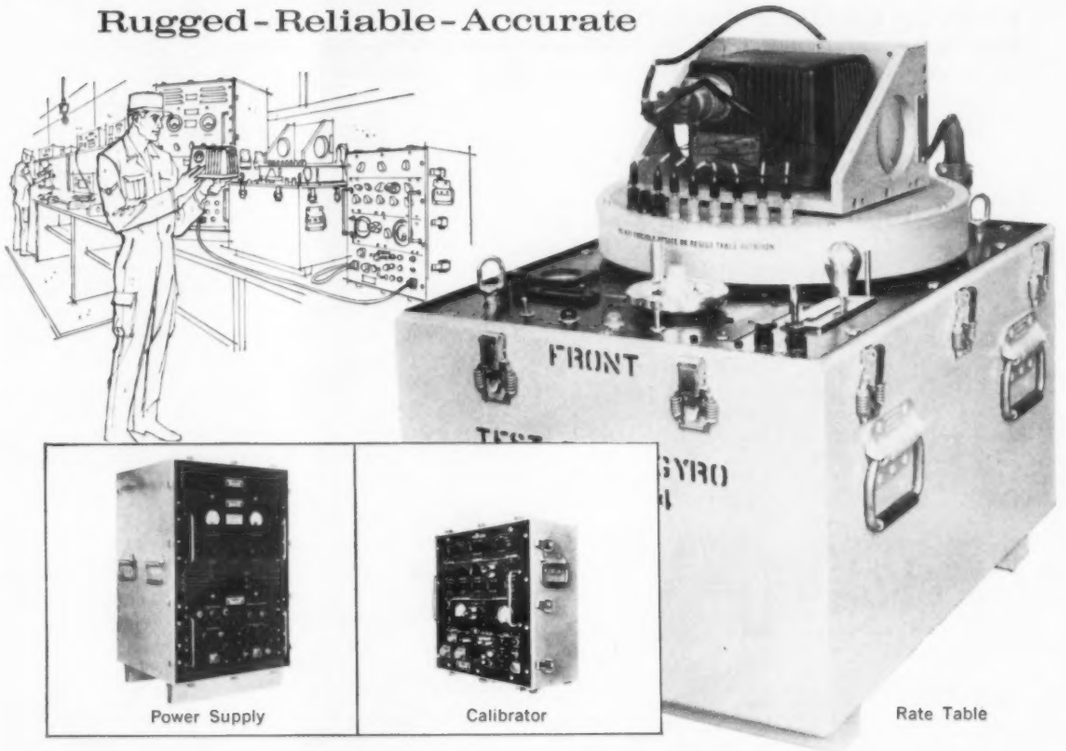

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The Honeywell Rate Gyro Test Set No. 32589 (FSN 4920-705-7536) has been accepted by the Air Force. Over eighty have been purchased for use at squadron level. This equipment combines the *ruggedness* to withstand the abuse of field service, the *reliability* associated with the environmental specifications of MIL-E-4970, and the *accuracy* of a laboratory instrument. Highly trained technical personnel are not required to operate this equipment.

This Gyro Test Set consists of a Rate Table, Calibrator, and precision Power Supply. *Rate Table,** with holding fixture for instrument under test, is turned at a variable angular rate up to 120 degrees per second. The Table is self-calibrating at 5 deg/sec. increments by means of a built-in stroboscope. Input rates are continuously variable. *Calibrator* permits checking pick-off voltage outputs for many other devices such as accelerometers and rate-of-turn indicators. AC pick-off output voltages can also be measured. *Power Supply* is 400 cps but other frequencies for pick-off or motor may be used. Write for Technical Bulletin BM-SGT-1 to Minneapolis-Honeywell, Boston Division, 40 Life Street, Dept. 13, Boston 35, Massachusetts.

*Available separately

CUSTOM DESIGN

For ranges up to 1200 deg/sec., and accuracies and tolerances other than described above, Honeywell can custom design and manufacture specialized Gyro Test Equipment to requirements.

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Electronic Circuitry

A continuing MILITARY SYSTEMS DESIGN feature, these circuits are selected because they represent good design. Significant characteristics which are not self-evident from the diagram are explained in the printed commentary.

DELAY LINE CLOCK

A simple clock circuit (Fig. 1) for making jitter and absolute time measurements uses a delay line, having a delay time of 0.2 μsec and a characteristic impedance of 500 ohms, for its "meter stick." The accuracy of the measurement will be within Δ, the delay time of the line, in this case to within 0.2 μsec.

The output of the clock circuit is a train of pulses which can be counted by any suitable digital counter. The clock is started by a positive pulse input at point A, inverted in Q1. It is amplified by Q2 and differentiated with its leading edge coupled to the base of Q3

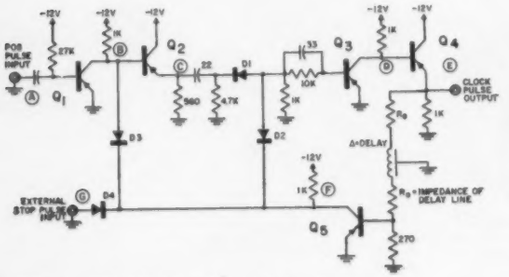


FIG. 1. **DELAY** Line Clock Circuit.

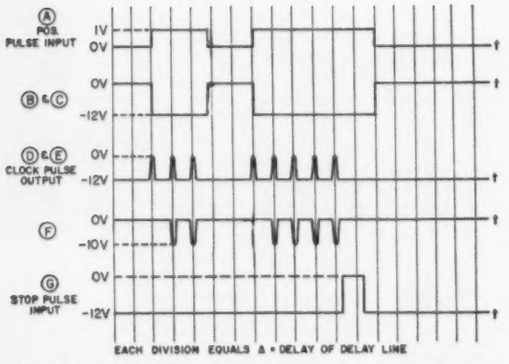


FIG. 2. **PULSE RELATIONSHIPS,** Delay Line Clock.

through D1. This causes Q3 to saturate. The pulse appearing at point D is inverted by Q4 and delayed by ΔL, then cuts off Q5. Output from Q5 is coupled back into Q3 by D2. Thus a continuous circulation of pulses spaced $\Delta\mu$sec apart appears at the output. On the trailing edge of the input pulse the voltage at B drops to 0, clamping the point F to zero through D3, and stopping the succession of pulses (Fig. 2). An alternate method of stopping the clock is to apply a 12v positive pulse at point G which will also clamp point F to zero.

To measure pulse repetition period an input square wave signal corresponding to the separation between two successive pulses of the sample to be measured, must be used as the input pulse. This can be done by feeding the sample pulse train into a flip-flop that triggers on the first pulse and resets on the second pulse.

If the difference in time between two pulses is to be measured, D3 is removed from the circuit, allowing the clock to free run after the first pulse. The second pulse is fed to the external stop pulse input, and the clock output measures the difference in time between the start (first) and stop (second) pulse.

Transistors: 2N499, 2N501 or 2N500

Diodes: T9G

Input pulse: 1 v positive pulse of duration to be measured. With 30μf tantalytic input capacitor, Max pulse length $>$ 2 msec.

Stop pulse: 12 v positive pulse, duration $>$ $\Delta\mu$sec.

Source: Ronald M. Sonkin, ITT Laboratories, Nutley 10, N. J., Also *Electronic Industries*, Feb. 1961.

BLOCKING OSCILLATOR

Coincidence circuits used in nuclear studies are designed to be actuated only when two or more events occur simultaneously. In the circuit shown (Fig. 3) photomultiplier outputs are first passed through a blocking oscillator which in turn produces a standard 2 v pulse into a 100 ohm load. If the input pulse is sufficient, when added to the preset bias (—7 to —5 v) to bring the instantaneous voltage to —4 volts will produce a "standard" output pulse. With each 14-stage 6810A photomultiplier coupled to its discriminator circuit through a single grounded base stage which provides a gain of about 2 and serves to match the cable from the photomultiplier, no further amplification is necessary.

Marginal pulses may produce a time jitter of about 7 nsec, and input pulses are usually only about 0.01 μsec in duration. Dead time is about 25 nsec.

The transformer windings in Fig. 3 are each two turns of No. 30 AWG wire wound through two ferrite beads. The 100 ohm resistor in the collector circuit protects the transistor by limiting the collector current. When the "length" switch is in the "short" position the diodes are reverse biased and are essentially open. After firing, the blocking oscillator draws current which charges the 100 ohm-270 $\mu\mu$f RC circuit in the emitter lead. This reduces the

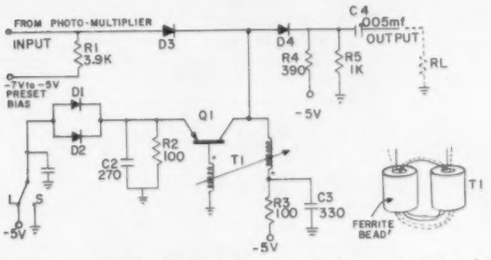


FIG. 3. **PULSES FROM** Photomultipliers are "standardized" by blocking oscillator circuit.

emitterbase voltage, turning off the transistor after about a 16 nsec pulse.

When the length switch is in the "long" position, the impedance from the emitter to ground is essentially the forward resistance of the diodes. The transistor then turns on much harder and produces an larger pulse about 0.1 μsec long. The function of the length switch is thus to change the resolving time of the discriminator—a variation which is convenient when setting up an experiment.

Input: Pulses 0.5 v to 3v, approx. 0.01 μsec duration.

Output: Pulses 2v amplitude into 100 ohm load.

Resolving time of discriminator: 16 nsec with "length" control in "short" position, 0.1 usec in "long" position.

Max time jitter: 7 nsec.

Dead time; 25 nsec.

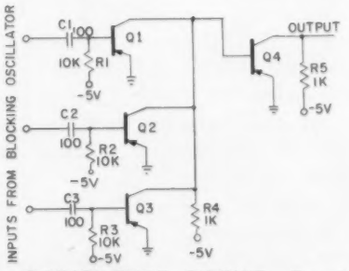
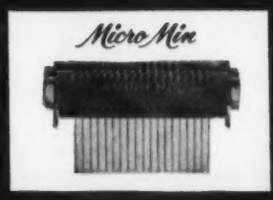


FIG. 4. **COINCIDENCE CIRCUIT.** Transistor Q4 operates only when inputs from three blocking oscillators arrive simultaneously.

The *coincidence circuit* (Fig. 4) receives pulses from several blocking oscillator circuits. Each of the first three transistors is normally saturated, holding Q4 in the "off" state. Only when pulses arrive at all inputs simultaneously (or when some of the input transistors are switched out) will Q4 be turned on.

Source: Mr. Martin Feldman, Laboratory of Nuclear Studies, Cornell Univ., Ithaca, N. Y. Also Review of Scientific Instruments, December 1960.



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Type	Maximum Anode Voltage (DC or Peak AC) ± Volts	Maximum Average Forward Current 75°C mA	Maximum Gate Current to "Fire" μA	Gate Voltage to Fire + Volts	
				Min.	Max.
2N884	15	200	20	.44	.60
2N885	30	200	20	.44	.60
2N886	60	200	20	.44	.60
2N887	100	200	20	.44	.60
2N888	150	200	20	.44	.60
2N889	200	200	20	.44	.60

Available for the first time in the miniature TO-18 case, these units offer the same high sensitivity and close characteristics control introduced by SSPI in pioneering PNPN devices for control and logic applications.

The precise firing characteristics of these devices make them ideal for timing and time delay circuits, voltage limit detectors, high gain static switching, logic circuits, and related applications.

With the high surge capability of this series, squib firing systems requiring pulse currents up to 5 amperes can be greatly miniaturized without sacrificing design margin. In addition, the low 1 mA holding current level is particularly useful in many programming, control and logic circuits.

Designed to meet the requirements of MIL-S-19500, these units are subjected to extensive temperature storage and cycling, as well as 100% acceptance testing, as a regular part of the manufacturing procedure.

Write for Bulletin C420-03.

CIRCLE 22 ON READER-SERVICE CARD

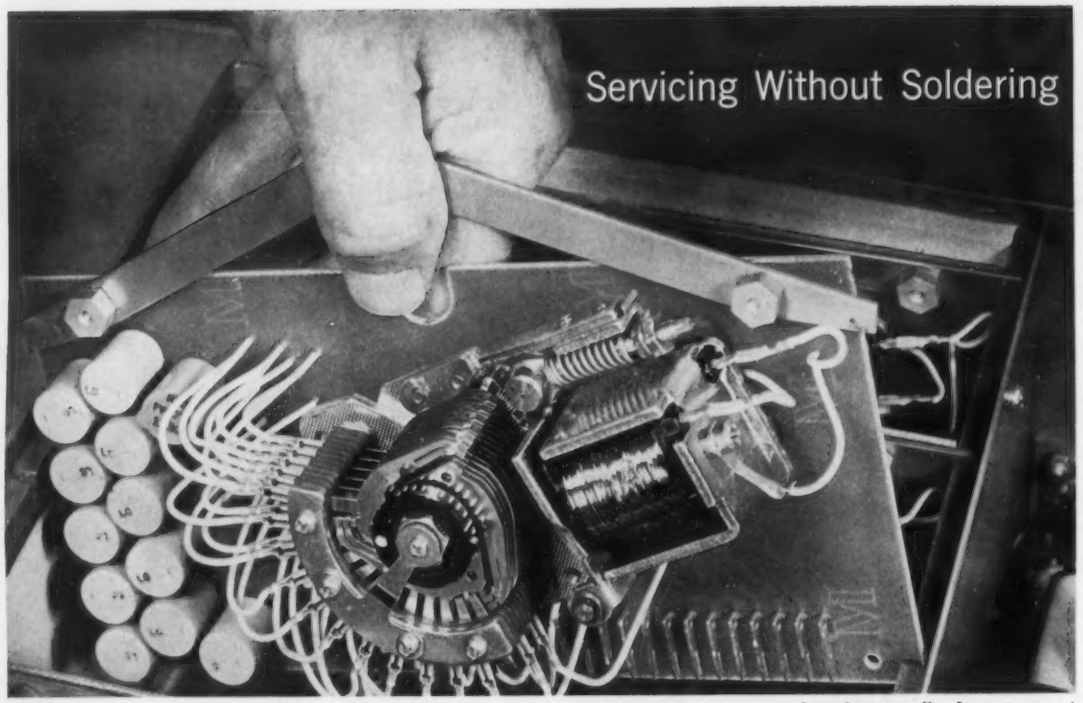
PROVEN LEADERSHIP IN *PNPN* TECHNOLOGY . . . from SSPI

SOLID STATE Products, Inc.

ONE PINGREE STREET • SALEM, MASSACHUSETTS
PIONEER 5-2800

Are you on our mailing list for "New Design Ideas"?

CIRCLE 21 ON READER-SERVICE CARD



The new NLS 481A digital voltmeter features both plug-in stepping switches and a snap-out readout that virtually eliminate use of a solder gun or other tools in servicing. Note the "finger-control" leverage bars for easy switch removal.

Applications include production testing, instrument calibration, laboratory testing, receiving inspection.

The 481A features the basic circuitry of the NLS 481, today's most widely used digital voltmeter.

Announcing the NLS Low-Cost 481A Digital Voltmeter

Here is the time-proved 481 with new features to permit replacement of all stepping switches and decade resistors in minutes instead of days. Plug-in stepping switch assemblies in the 481A also allow troubleshooting by the substitution method. Like the thousands of 481s in use, the new 481A features ±0.01% accuracy and completely automatic operation at low cost. It measures DC voltage from ±0.001 to ±999.9; AC or low-level DC with plug-in accessories. Input impedance is 10 megs... balancing time is 1 second, average... internal standard cell verifies calibration.

Although the 481A features exclusive plug-in stepping switches previously found only on higher cost NLS digital voltmeters, it sells for only $1,525, complete. Delivery is from stock – 15 days if stocks are temporarily depleted. NLS will continue to manufacture the 481 in volume for customers who have standardized on this instrument or where initial price is more important than the long-term savings in servicing offered by the 481A.

A statement of policy: The 481 A is not a "pie-in-the-sky" instrument or prototype. It has long since undergone complete testing and is now in volume production to assure you prompt delivery of a fully-tested, quality instrument.

Call your NLS regional office or sales representatives for a demonstration of the 481A, 481 or any digital measuring instrument. If you prefer, please contact NLS for additional information.

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR, CALIFORNIA

CIRCLE 359 ON READER-SERVICE CARD

"FANNING" CIRCUIT FOR TIMER

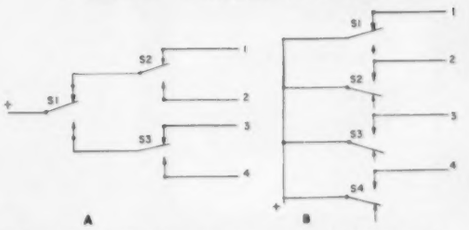


FIG. 6. FANNING switch arrangement (A) provides almost instantaneous transfer of load without possibility of simultaneous loading of more than one circuit. Four single cam-operated switches (B) are almost impossible to design to give same degree of precision.

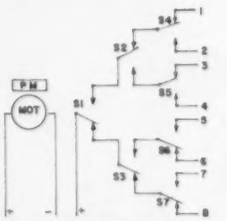


FIG. 7. EIGHT CIRCUIT timer uses seven cams and switches.

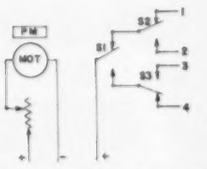


FIG. 8. VARIABLE SPEED 4-circuit timer.

A. W. Haydon's patented invention relates to electrical switching apparatus for successively supplying current from a common source to a plurality of electric circuits. Essentially, this is a timer consisting of a motor turning a cam shaft, on which are affixed cams to actuate electrically interconnected switches in a predetermined order.

Advantages of timers employing the Fan technique include: Limitation of transfer time to a few milliseconds, economy of power supply and generator capacity by continuous loading, and economy in switches (one less than total number of output circuits is required).

In Fig. 6 a typical fanning circuit is compared with a standard circuit using independent cam-operated SPST switches. (The schematic arrangement of the switches forms the pattern of a fan—hence its name.)

Three SPDT switches are connected as shown (Fig. 6a). In the starting position, output No. 1 is energized. S2 then transfers energizing output No. 2. Then S1 transfers energizing No. 3 followed by transfer of S3 energizing output No. 4. S2 returns to its original position at about the time S3 transfers so that when S1 returns to its original position, output No. 1 is energized again and the cycle can then be repeated. By proper selection of cam cuts the outputs may be made of either equal or unequal time duration. By adding switches in a symmetrical manner to the right hand side of the circuit, any required number of output circuits may be provided. These output pulses can be generated with one less switch than the required number of pulses. If switches are added in the symmetrical manner described, the characteristic of no delay or overlap between pulses is maintained.

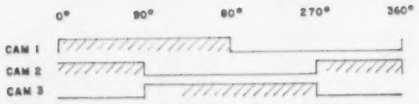


FIG. 9. RELATIVE CAM SETTING for three-switch 4-circuit timer.

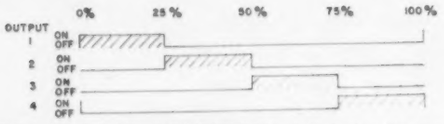


FIG. 10. LOAD CONDITION with 4-circuit cams set as in Fig. 9. Note no over-lap and no zero-load periods.

Fig. 7 shows a 8-circuit timer consisting of a constant speed motor and 7 cam-operated switches. The addition of a variable resistor, shown in the 4-circuit diagram, (Fig. 8) permits the cycle time to be varied.

Fig. 9 shows a specific setting relationship of 3 cams, each having a 180-degree lobe. The three switches operated by these cams, when wired as shown in Fig. 8, will produce the circuit condition shown in Fig. 10.

Source: Richard Varis, Design Engineer, The A. W. Haydon Co., Waterbury, Conn. (*Bulletin N. L. 90 giving more information is available. For this literature circle No. 126 on reader Service Card.*)

TUNNEL DIODE IS READOUT SWITCH ELEMENT

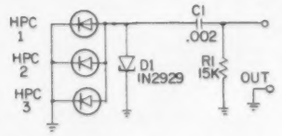


FIG. 11. TUNNEL DIODE provides fast switch pulse when actuated by slowly changing inputs.

In many readout applications a relatively slow increase in output voltage must actuate a counter or relay. Tunnel diodes can often be used to give fast switching when the critical voltage (Vp) is reached even though the light level (in the case of a photoelectric readout) is changing at a relatively slow rate. Three HPC (Hoffman Silicon Photovoltaic Cells) Fig. 11 provide a coded aperture readout for switching the 1N2929 tunnel diode.

The HPC cells provide an input pulse of 0.5 volts, approximately 1 ms in duration. The output shows a positive-going pulse of about 0.2 volts amplitude and 0.05 milliseconds duration at the beginning of the input pulse, followed by a negative-going pulse of the same amplitude and duration at the end of the input pulse.

Source: E. F. Koshinz, Manager, Applications Engineering Section, Semiconductor Division, Hoffman Electronics Corporation, 1001 Arden Drive, El Monte, California.

KEARFOTT SIZE 5 COMPONENTS

FOR SERVO SYSTEM MINIATURIZATION

SHOWN ACTUAL SIZE

A complete family of Size 5 components for every servo system function is now available from Kearfott. This series offers the system designer complete latitude in miniaturization of his second-generation systems, with the performance and reliability heretofore found only in much larger units.

Stainless steel housings, shafts and bearings protect the units against environmental extremes and contribute to stability under shock, vibration, and temperature fluctuations. • Standard 26-v, 400 cps excitation. • Synchro and resolver accuracy ±10 min. • Operating temperature range −55° to +125°C. Computer-designed for optimum performance.

CHARACTERISTICS

SYNCHROS

	VOLTAGE (400 cps)	CURRENT (amps)	IMPEDANCE INPUT	IMPEDANCE OUTPUT	T.R.	NULL (mv)	ERROR (min)
Transmitter							
CJO 0565 100	26	.045	576/74.7	94.2/71.4	.454	34	10
Control Transformer							
Low Z-CJO 0555 100	11.8	0408	250/73	1085/72	1.765	34	10
High Z-CJO 055 900	11.8	0202	550/74	2390/73	1.765	34	10
Differential							
CJO 0595 100	11.8	0408	250/72	313/69.8	1.154	34	10
Resolver							
Low Z-CJO 0585 100	26	.0485	537/64.7	677/74	1.0	34	10
High Z-CJO 0589 100	26	.0145	1795/68.1	2210/76	1.0	34	10

Weight: 0.90 oz; Length: 1.250 in.

SERVO MOTORS

	J126-06	J126-02
No-Load Speed	9800 rpm	9800 rpm
Stall Torque	0.10 in. oz	0.10 in. oz
Rotor Moment of Inertia	0.175 gm cm²	0.175 gm cm²
Voltage φ1/φ2 (400 cps)	26/36-CT	26/26
Power Input/Phase	1.7 w	1.7 w
Duty	continuous at stall	

SYNCHRONOUS MOTOR

	CJO 0172 200
Pull-In Torque	0.06 in. oz
Pull-Out Torque	0.10 in. oz
Pull-Out Power	4 w
Length	1.24 in.

MOTOR GENERATORS

MOTOR	CJ4 0812 001	CJ0 0812 650	CJ0 0813 200
Voltage φ1/φ2 (400 cps)	26/36-CT	26/36-CT	26/26
Power/φ	1.5 w	1.5 w	1.5 w
No-Load Speed	8000 rpm	8000 rpm	8000 rpm
Stall Torque	0.10 in. oz	0.10 in. oz	0.10 in. oz
GENERATOR			
Voltage (400 cps)	26 v	26 v	26 v
Power	1.5 w	1.5 w	2.0 w
Volts/1000 RPM	0.1 v	0.1 v	0.5 v
Null	1.3 mv	10 mv	6.7 mv

Weight: 1.05 oz; Length: 1.507 in.

GEARHEADS, BRAKES, CLUTCHES

Size 5 gearheads range in reduction ratios from 20:1 to 1019:1 for servomotors and motor tachometers above. In addition, Size 6 clutches, brakes, and brake-clutches are available.

Write for complete data

KEARFOTT DIVISION
Little Falls, New Jersey

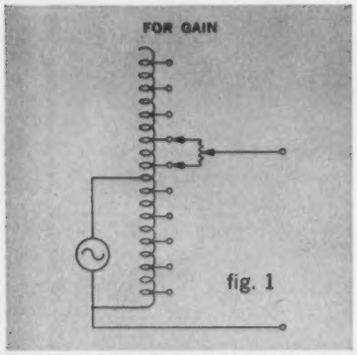
GENERAL PRECISION, INC.
Other Divisions: GPL, Librascope, Link

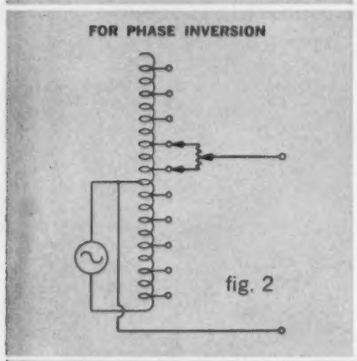
CIRCLE 23 ON READER-SERVICE CARD

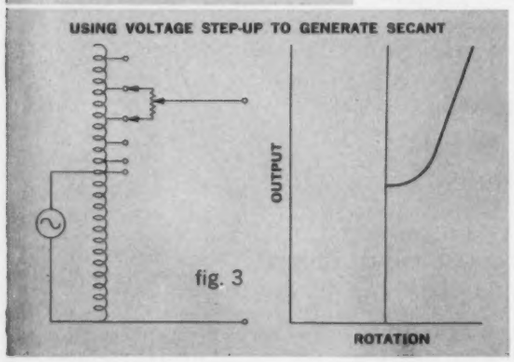
vernistat®
design report

Information on Vernistat a.c. potentiometers for design engineers

VERNISTAT GENERATES A TRIG FUNCTION — CANCELS OUT A SERVO SYSTEM







You get some interesting variants just by moving an input connection of the Vernistat from one end of the autotransformer to some other point. For example, you can use this set-up for voltage gain or phase reversal, as Figures 1 and 2 show.

If you play around with the spacing of the taps on the autotransformer, you get a nonlinear output. What's more, if you locate all the taps in the unexcited portion of the winding, the output voltage ratio will always be greater than 1 — a prime necessity for the secant curve.

This was observed by shrewd designers who were looking for a way to simplify a secant generator. It consisted of a servo amplifier, servomotor and resolver. The cosine winding of the resolver put out a feedback signal which was inverted in the servo so that a reciprocal secant voltage appeared at the output. All three units were replaced by a **single** Vernistat a.c. potentiometer modified as shown in Figure 3.

The step-up characteristic of the Vernistat can also be used to extend its output beyond the 0 to 100% rotation points **while maintaining slope and linearity.** "Extended Slope" Vernistats are useful wherever transients may cause overshoot of the potentiometer wiper. They are self-correcting and eliminate the need for accurately located and high-torque stops.

As for nonlinears—Vernistat has flung open the door to a resplendent variety of mathematical outputs **which you can set by hand!** Ask about our Adjustable Function Generator. Cute, quick, but definitely not a toy!

"CARPE DIEM" — "Seize the Day" — ought to be the motto of every original equipment designer who runs in analog computer or servo circles. One of the opportunities you can seize is Vernistat in any of its varieties. We will gladly send you literature to help you get a good grasp of the subject.

CIRCLE 24 ON READER-SERVICE CARD

LET'S TALK CONSTRUCTION

For voltage-dividing, the Vernistat uses a toroidally-wound **autotransformer** over a tapewound magnetic core. Thirty-one precisely located taps are connected to a printed-circuit commutator, then the whole assembly is cast in epoxy resin. The commutator is heavily plated with rhodium to prevent wear, and all other contacts are made with precious metal alloys.

For voltage pick-off, an interpolating pot is shifted sequentially between adjacent taps. Switching is automatic with shaft rotation resulting in a smooth, continuous, accurate, linear voltage change. Since the interpolating pot bridges only a small fraction of the input voltage, large wire of low resistivity can be used for its winding — an important factor in achieving low output impedance and long life.

The Vernistat uses a planetary gear system to control the position of the pot along the autotransformer. With this design, it takes 10 turns (even as high as 30 turns of the shaft in some models!) to cover the voltage range. That's one reason why you get such high resolution with the Vernistat.

All aspects of Vernistat design — including insulation and lubrication—meet the most finicky MIL environmental tests. If reliability, precision and rugged construction are what you're looking for, Vernistat a.c. pots can fill the bill. **Take heed all automators, computer-men, servo-mechanicians and instrument fanciers!**

vernistat division
PERKIN-ELMER CORPORATION
778 Main Ave., Norwalk, Connecticut

SUBMINIATURE SERVO DRIVE CIRCUIT

A new subminiature servo drive system for lightweight control applications which provides a 2 in-lb torque at the actuating arm from an error voltage of 0.001 volt and with an actuator arm speed of 270° of rotation/second, uses a simple feedback of motor-generated voltage to produce a damping voltage. This arrangement enables the servo to stop instantly on command without overshoot or hunting about the null position.

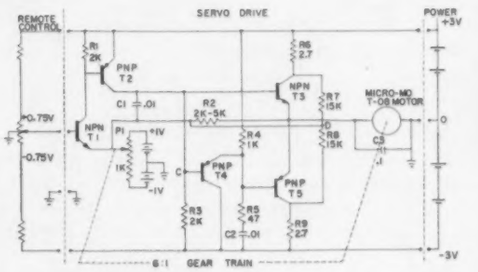


FIG. 12. TWO-OUNCE servo provides 2 in-lb. torque, meets most mil-specs.

The schematic diagram of the servo amplifier is shown in Fig. 12. In the neutral or zero signal condition, the base voltage of NPN transistor T1 is set at a level which keeps the driver transistors T3 and T5 in the turned-off condition. In this condition the two PNP transistors T2 and T4 form a direct-coupled amplifier chain in which T4 is normally conducts so that its emitter is at one-half supply voltage.

When a positive signal is applied to the base of T1 it increases its conduction, driving the base of T2 negative which drives it toward increased current, causing the voltage drop through R3 to increase and the potential at point C to swing positive. This causes NPN transistor T3 to conduct through the motor and the upper battery loop driving the motor clockwise, for example. At the same time T4 remains cut off. As the motor turns, potentiometer P1 is driven positive, which reduces the base-emitter potential difference at T1 until T1 decreases its current. This in turn causes T2 to decrease conduction, point C to be driven negative, and T3 to cut off, blocking current to the motor.

The voltage across the rotor is equal to the voltage drop in the rotor plus the counter emf generated in the rotor. The voltage across resistors R6 and R9 when combined by means of R7 and R8 is proportional to the voltage drop in the rotor but opposite in sign. This, when combined with the rotor voltage at point D, leaves only the back emf which is fed back in a degenerative fashion to the emitter of T1 to supply a damping action equivalent to conventional rate generator damping.

In similar manner, when a negative signal is applied to the base of T1 it will increase in emitter-collector resistance, T2 will decrease in conduction, driving point C more negative, causing T3 to remain cut off but causing T4 to conduct which drives the base of T5 negative with respect to its emitter, allowing it to go into conduction. This completes the lower battery

NEW—TRAK OSCILLATOR CAVITY FOR CW SERVICE!

This MINIATURE TRAK Type 9127-SL(CW) Microwave Cavity is ideal as a local oscillator or low power transmitter in the new 2.2—2.3 KMc telemetry band. With a power output in excess of 100 mw, it is also suitable for use as a parametric pump, or the energy source for harmonic generators.

Specifications are:

Frequency	Tunable 2.15—2.45 KMc
CW Power Out	Greater than 50 mw over entire tuning range Greater than 100 mw over 2.2—2.4 KMc range
Power Input	150 VDC at 10 ma and 6.5 V at 240 ma
Temperature Stability	Less than 1 Mc drift with a temperature variation of 80°C. Operable from −70° to +120°C.
Size	1" diameter by 4¾" long
Weight	7 ounces

TRAK MICROWAVE has miniature CW Oscillators with output power of 10 mw to 2 watts at frequencies between 800 and 7000 Mc. Also, Oscillators engineered to your specifications!

Write today for **new** Catalog 61A, full of oscillators for CW, grid pulse and plate pulse service.

Microwave Oscillator Engineers Wanted

TRAK MICROWAVE CORPORATION
Subsidiary of
TRAK Electronics Company
5006 N. Coolidge Avenue
Tampa 3, Florida
REdwood 6-6422

CIRCLE 357 ON READER-SERVICE CARD

loop which drives the rotor in counter-clockwise direction and the arm of P1 in a negative direction.

Power Supply:—3v to +3v Max.; Full load current 400 ma, Zero signal current, 10-20 ma.

Signal Input: 0 to ±0.75

Torque: 2 in-lbs from error voltages of 0.01v.

Total weight of system less batteries: 2.0 oz.

Source: Herschell Toomin, design engineer, also *Technical Bulletin, Solid State Subminiature Servo Drive System* T005, Solidtronics Div., of Electrosolids Corporation, 14751 Keswick St., Van Nuys, Calif.

FOR THIS LITERATURE CIRCLE 127 ON READER-SERVICE CARD

OSCILLOSCOPE AMPLIFIER

A symmetrical direct-coupled amplifier which inherently cancels out instabilities due to drift in supply voltage is shown in Fig. 13. The signal is applied in a differential fashion, being balanced against electrical ground by the centering pot R2. The two cathodes of V1 are both biased −70 volts with respect to grid and are always at the same potential.

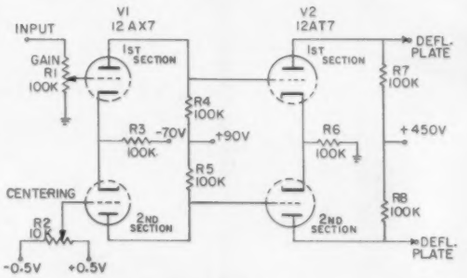


FIG. 13. SYMMETRICAL DC amplifier cancels instabilities due to supply voltage drift.

A positive excursion of the input grid of V1 will tend to increase the current in the first section of V1. This will increase the voltage drop in the cathode resistor, R3, driving the cathodes positive with respect to ground. Since the grid of section 2 of V1 is held at ground potential, this effectively forces the grid of section 2 in a negative direction with respect to its cathode, diminishing the plate current drawn by the plate of section 2, V1.

The potential of the plate of the first section of V1 will therefore tend to fall, decreasing the potential of the first section grid of V2. In like manner, potential on the plate of the second section V1 rises, carrying with it the grid of the second section of V2, achieving push-pull action at the plates of V2 which are connected directly to the vertical deflection plates of the oscilloscope.

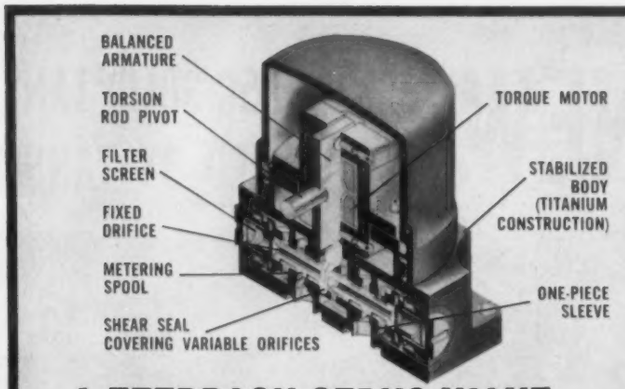
The power supply provides a total of 520 v, dc to a voltage divider, grounded at a point 70 v from the negative end.

Bandwidth of the amplifier is essentially flat from 0 to 10,000.

Output: 200v peak-to-peak max.

Voltage Gain: Approximately 1000 with input of 0.2 v max.

Source: Dr. A. V. J. Martin, 79 Rue Duhesme, Paris 18, France also *Electronic Design*, February 4, 1959.



A FEEDBACK SERVO VALVE WITHOUT SPRINGS OR LEVERS

- **Unity coupled Hydromechanical Feedback**
- **High Null Accuracy** ■ **Only 2 moving parts**
- **Large, full opening, shear-seal orifices**

This two-stage, four-way flow control valve is the only one available that provides true positional feedback without springs or levers. The first stage consists of an electrical torque motor and "shear-seal" orifice hydraulic amplifier, while the second or control stage is made up of an accurately matched spool and sleeve arrangement.

Hydromechanical unity feedback relates spool position to torque motor armature position and also nulls out effects of orifice variations due to supply pressure and temperature fluctuations. Flow force reactions are thus substantially reduced and hydraulic centering of pilot position is feasible without spring hysteresis and null shift. Large orifices prevent clogging and silting and high shear forces permit efficient operation even with highly contaminated fluids. Final null adjustments are made electrically by a balancing control at amplifier output stage.

TYPICAL CHARACTERISTICS

	Medium Flow (#6103-#6106)	High Flow (#6104)
Rated flow	to 7.5 gpm at 3000 psi valve pressure drop	to 18.0 gpm at 3000 psi valve pressure drop
Hysteresis	3% maximum total rated current	3% maximum total rated current
Supply pressure	300 to 3000 psi	300 to 4000 psi
Proof pressure	4500 psi pressure port 3000 psi return port	6000 psi pressure port 3000 psi return port
Pressure gain	First stage—500 psi per ma minimum with 3000 psi supply	First stage—500 psi per ma minimum with 3000 psi supply
Load pressure gain	8500 psi per ma minimum with 3000 psi supply	10,000 psi per ma minimum with 3000 psi supply
Temperature	−65°F to +275°F	−65°F to +275°F
Maximum Null Shift (% of rated current)		
Temperature Change per 100°F	1%	1%
Supply Pressure Variation ±	2%	2%
Quiescent Current Change 20%	1%	1%
Weight	12 ounces	16 ounces

TORQUE MOTOR: Note: 6103 & 6106 Identical with exception of torque motor characteristics.

	Valve #6103	Valve #6106
Input Power	300 Milliwatts	64 Milliwatts
Rated Current	± 10 ma	± 8 ma
DC Coil Resistance (other motors also available)	3000 ohms/coil	1000 ohms/coil

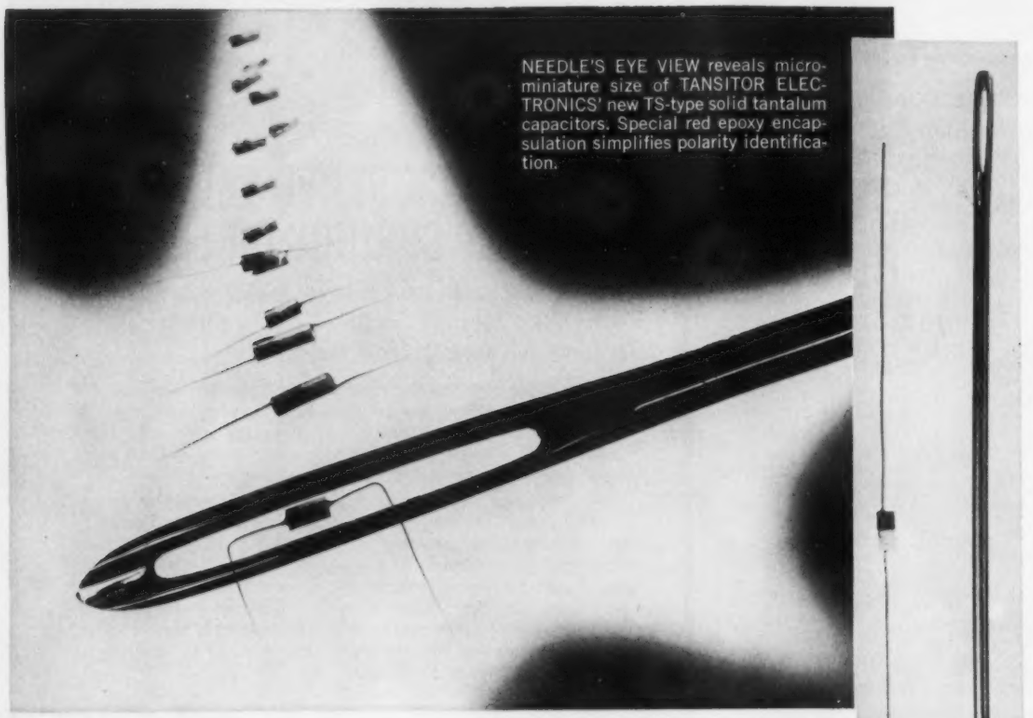
Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.

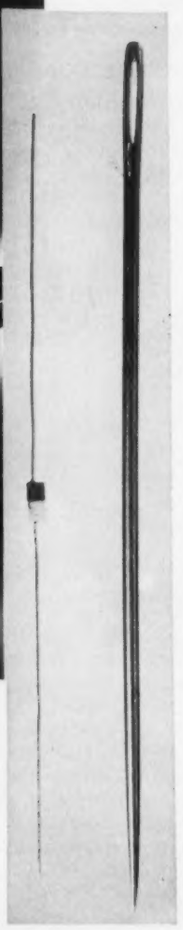
Little Falls, New Jersey

CIRCLE 25 ON READER-SERVICE CARD

NEW –55 to +85C SOLID TANTALUM CAPACITORS ANNOUNCED BY TANSITOR ELECTRONICS



NEEDLE'S EYE VIEW reveals microminiature size of TANSITOR ELECTRONICS' new TS-type solid tantalum capacitors. Special red epoxy encapsulation simplifies polarity identification.



Actual Size

Ranging in capacitance from 0.01 to 20 microfarads and in working voltages of 3 to 15, TANSITOR'S new TS-type solid tantalum capacitors operate at −55 to +85C. But, they can be stored at −80 to +125C and are not damaged by short time 125C assembly temperatures.

Ideal for microminiature applications, they range from 0.150 to 0.313 inches in length and 0.065 to 0.103 inches in diameter. The Mylar* insulating sleeve and encapsulated body insure reliability under severe environmental conditions.

*T.M. E. I. DuPont de Nemours & Co.

MORE DETAILS?

A complete technical data sheet is readily available. Address your inquiry to: TANSITOR ELECTRONICS, INC., Section 12, West Road, Bennington, Vt.

SEE OUR SPECIFICATIONS IN VSMF THE MICROFILM CATALOG FILE

TANSITOR
ELECTRONICS INCORPORATED
Where Reliability Comes First
Tantalum Capacitors

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Bias Stabilization of Small-Signal Transistors

The dc, no-signal values of collector voltage and emitter current establish the operating point of a transistor. This bias voltage and current must remain stable over a wide range of operating temperatures. However, both the reverse-bias collector current and the emitter-base junction resistance tend to vary with temperature to such an extent that exernal stabilizing circuits must be used to maintain stable bias conditions, and to hold transistor characteristics linear for small-signal amplification. These variations are also important factors in large-signal operation, to be discussed later.

Reverse-bias Collector Current Variations. Saturation current, also called reverse-bias collector current and collector-base leakage current and designated I_{cbo}, consists (in an NPN transistor) of a flow of electrons in the base region to combine with holes from the collector region at the base-collector junction (see second article, this series). In a PNP transistor the roles of the holes and electrons both minority carriers, are reversed.

The saturation current varies with temperature of the transistor from almost zero at 10°C to over 1 ma at 125°C. This (in the NPN transistor) is

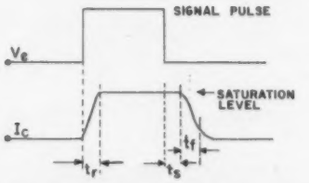

FIG. 1. SATURATION CURRENT in Common-base configuration. V_e is step signal pulse applied to emitter, I_c is collector current response. t_r is rise time; t_s, storage time, and t_f is fall time, measured to 90% of final value.

essentially a flow of holes from the collector into the base region. If the resistiveity of the base region is high, or if a high value resistor is connected in the base lead, an accumulation of holes in the base region will result. These will in turn attract an increased number of electrons from the *emitter*, increasing the collector current, which in turn tends to increase the temperature of the collector-base junction. Increased temperature leads to more saturation current, and so on, which is evidence of a run-away condition. This will lead to severe distortion, an inoperative transistor, or a destroyed transistor. This condition can be prevented or minimized by *keeping the base-lead resistance low*, particularly in the case of power transistors.

In circuits designed for saturation operation, such as in computers, a sustained step signal may be applied to the emitter. The resulting large collector current causes a large voltage drop in the load resistance which in turn reduces the voltage across the collector-base barrier. Because the flow of minority carriers is limited by the low collector-base

voltages rather than by the input signal, the excess minority carriers are stored in the base region. Upon removal of the emitter signal step voltage, the excess carriers slowly drift into the collector region, holding the collector current at saturation value for the duration of period called the "storage time" (Fig. 1), before it drops exponentially to zero.

Emitter-Base Junction Resistance is another factor contributing to instability in transistor bias. This resistance is characterized by a negative temperature-coefficient, so that the resistance falls as the temperature rises, causing collector current to increase. This effect operates even when saturation current is near zero. The method of reducing this effect is to use a high-value resistor in the emitter lead.

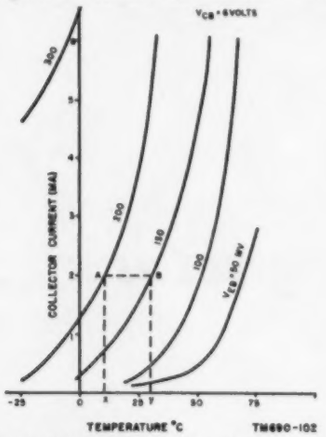

FIG. 2. VARIATION of collector current with transistor temperature.

This minimizes the effect of the emitter-base junction resistance variation, since it becomes a small part of the total emitter circuit resistance. Because this resistor *swamps* the junction resistance, it is sometimes called a *swamping resistor*.

Fig. 2 illustrates the effect of temperature on collector current of a typical transistor, with V_{cb} held at 6 volts, and V_{eb} held constant at a succession of fixed values from 50 to 300 mv. The dotted line AB connects two points having the same collector current on two different emitter-base voltage curves, and suggests another solution to control of collector current. If the emitter-base voltage is reduced from 200 mv to 150 mv while the temperature rises from x to y (20°C), the collector current will remain stable. Methods for reducing emitter-base voltages include *thermistors, transistor combinations,* and *breakdown (zener) diodes.*

Note. This article, the fourth in a continuing MSD series, has been adapted in part from the U.S. Army Technical Manual TM 11-690.

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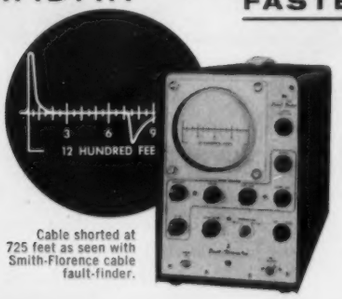

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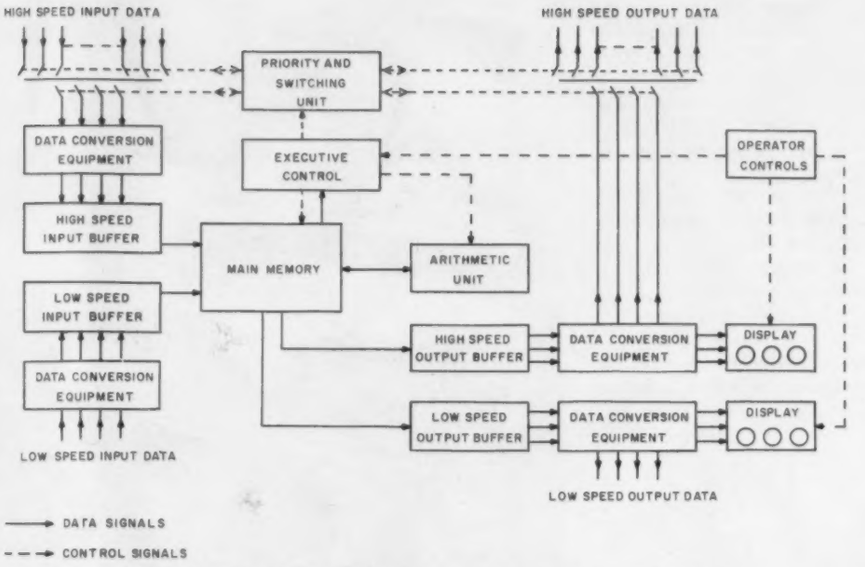

FIG. 1. "ON-LINE" military computers impose maximum speeds and highest reliability requirements.

Military - Type Computers

AUDREY CLAYTON, Melpar, Inc.

MILITARY REQUIREMENTS are guiding the future of computer technology. Compared with commercial and industrial demands, in every realm of analog and digital computing the Armed Services are faced with more data, more redundancy and the requirement for more accurate results more quickly. The scope of their problems is such that they must integrate all potentials of the electronic art in order to provide the requisite world-wide capabilities.

Soon long-range warning systems may scan an approaching rocket, compare its characteristics with those of known friendly and enemy equipment, and in case of a new type, extrapolate by features of similarity, to render an opinion as to whether or not counter-measures should be initiated.

The inconceivable complex of personnel and administration record-keeping for each service, possibly for all services, may be undertaken by a single organization.

Every airborne, sea-going, underwater or space vehicle may contain scanners for all types of radiation, bringing back records for correlation and reduction by high-powered, large-scale data-processing equipment.

Computers on ships and aircraft may provide rapid, high-accuracy navigation by reference to orbital satellites, whose position will be accurately determined at every instant.

Three-dimensional color displays will give an immediate and unambiguous interpretation of aircraft patterns or any other desired combat situation configuration.

Since all of the computer applications just mentioned are based on research actually in progress, it is safe to prophesy that computers in military applications will surpass all that has even been predicted for them.

Military "customers" for typical business type computers now include the Army Ordnance Supply system, Air Material Command, Army Signal Corps, Strategic Air Command, The Aviation Supply Office of the Navy, Bureau of Naval Personnel, the Naval Gun Factory, the Marine Corps—in fact, almost every military arm and agency. In addition to the whole gamut of commercial computer practice, a large class of problems peculiar to the tactical support of the armed services must be met. Thus mili-

tary computing applications range from logistics to missile guidance, from payroll processing to battlefield surveillance.

Although such factors as cost, speed, reliability, power requirements, etc., are important to non-military users as well; speed requirements increase by several orders of magnitude when the problem is one of fire control—to destroy an enemy aircraft approaching at supersonic speed. Computer reliability is at a premium in a satellite, where maintenance is impossible, or on a submarine, about to launch a Polaris missile. Available power is severely restricted on a battlefield, where the computer is in a jeep, and packaging techniques must be revolutionized if the equipment is to be hand-carried.

While the military, like industry, is involved in the processing orders, requisitions and paychecks, their primary concern is with the overall requirements and concepts of administration with computing systems rather than just with computers. In refining its system concept, the military must analyze the needs of every level and every branch of its organization, to determine the precise nature of these needs in the light of the technological ability to supply them. Thus, they require advances in areas which industry in general may need, but cannot yet afford to investigate; such as infra-red, radar, television, telemetering, microwave, tropospheric scatter, automatic switching within communications networks, computers talking to computers, visual displays, multiple control centers, portable computers, real-time controls, sub-systems within systems, etc. Yet at the same time, it may be more important to evaluate and improve tested components than to develop new ones. It may be more urgent to find a way to link two existing computing systems, than to increase their speed.

Due to the very magnitude and urgency of the problem, the military effort is devoting its organized thought and work in computer applications to the more effective managing of its entire enterprise.

Environment

Military computers are subjected to greater diversities of temperature, pressure, radiation and other environmental parameters than similar equipment in any other field of application. External temperatures vary from −80°F to +160°F, and humidity from zero to 100%. Wide variations in barometric pressure are encountered, with additional hazards such as salt, sand, dust, insects, fungi, and wind and ice load. In addition to weather conditions, the equipment must also be capable of operating after prolonged storage in any position. Specific applications introduce such further factors as roll and pitch on shipboard, with consequent gyroscopic action on magnetic drums; low pressure environment for airborne equipment with its deleterious effect on sealed components; satellite

Said Gaspard de Coriolis: *"A particle which is subject to no forces in a rotating coordinate system experiences a radial acceleration and a tangential acceleration."*

It was around 1840 that Coriolis discovered what has since become known as the Coriolis Effect. He noticed objects above the earth tend to rotate relative to the earth's rotation . . . to the right in the northern hemisphere, to the left in the southern.

The Coriolis Effect is in force in outer space, too. If a space vehicle is rotated in order to establish artificial gravity, the necessarily short radius of the rotation causes a Coriolis force. This creates orientation problems for a human occupant. To eliminate this difficulty, a scientist at Lockheed Missiles and Space Division conceived the idea of connecting the vehicle to an auxiliary fuel tank by a half-mile-long cable. Thus, if the whole system is then rotated at a reduced speed around its center of mass gravity, the longer radius greatly minimizes the Coriolis force. Right now—on the drawing boards at Lockheed—is an enormously advanced space vehicle system which utilizes this concept, in addition to many others.

Fortunately, natural laws are about the only restrictions which circumscribe scientists and engineers at Lockheed Missiles and Space Division. The climate in Sunnyvale and Palo Alto, on the San Francisco Peninsula, is close to perfection. The creative atmosphere—the opportunity to work on such important projects as the DISCOVERER and MIDAS satellites, the POLARIS FBM, or even more advanced concepts such as the space system cited above—is the dream of the creative engineer.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-11F, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

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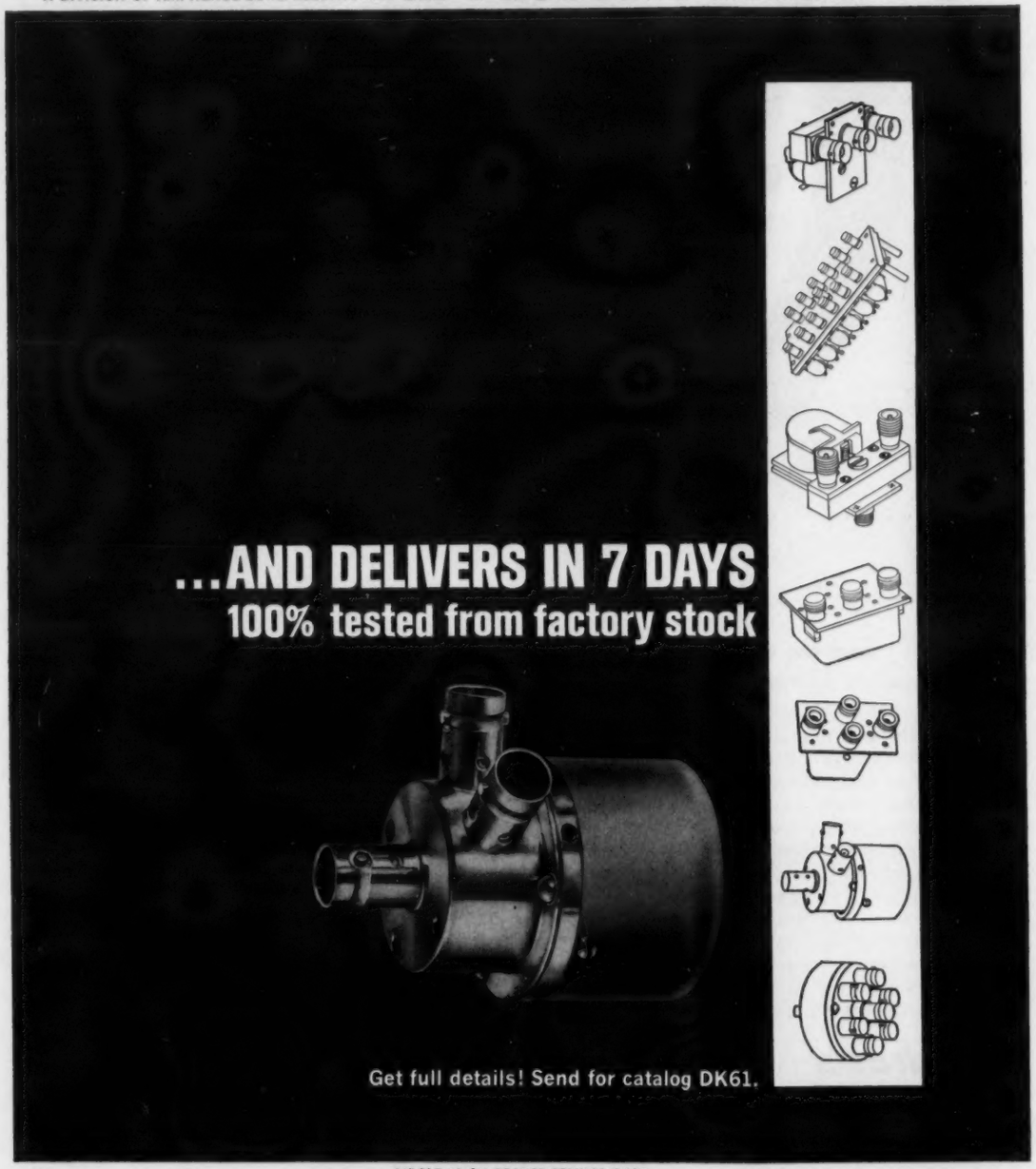

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computers experience extreme temperature ranges coupled with prolonged low pressures.

Reliability

Few non-military applications impose such stringent reliability requirements as military real-time, or "on-line" processing. A typical on-line military computer is shown in Fig. 1. Data flow is essentially continuous, and results must be computed and transmitted within a certain fixed, and usually very short, time. Normally the equipment must operate at its maximum speed and optimum configuration in order to complete the computation, with the accompanying conversions, in the specified time.

Standardization of circuitry and use of modularization techniques allow more rigorous pre-testing, with consequent reduction in failure rate, and drastically reduce the time required to locate and replace malfunctioning components, once detected. But even so, especially with large systems, the mean free-time between errors is quite short. Statistics provide a logical pattern for the statistical probability of obtaining any specified operating period without malfunction, for a fixed number of components.

Methods of reducing "down-time," however, are of little value in applications such as satellites, where maintenance is impossible once operation has been initiated. In this case, equipment redundancy, either on a component level, or with entire systems, may be used to reduce the possibility of malfunction, but there is no substitute for basic functional reliability. Design must be based on these considerations, in addition to the ever-present problems of size and weight.

Equipment Size

The question of equipment size is inevitably bound up with specific environments and includes wider variations than are to be encountered in commercial or scientific computing. At one extreme, the volume of data may be great.

On the other hand, space restrictions in shipboard, under-water, airborne or satellite applications impose severe and unavoidable limitations on volume, weight, and maximum dimensions. Extension of computer applications into the minutiae of battle control introduces a requirement for equipment which can be "back-packed," either in its entirety, or after separation into modularized units for ease of transportation. This latter possibility itself requires a whole new design philosophy.

These considerations provide the main impetus for the industry-wide drive toward micro-miniaturization. Packaging techniques must be refined to yield ultimate efficiency in space utilization. And yet the requirement for ease of maintenance is still of primary concern.

Data Volume

There are two major classifications of military problems in which the volume of data is excessive. One of these involves logistic and fiscal type operations, wherein records are handled for all military personnel, military equipment, spares, service records, etc. Here the requirements are to process an immense amount of data, to ensure accuracy (for instance in payroll processing), and to guard against information loss, since many of these records could not be duplicated.

At the other extreme, such as investigations of aerospace, the data to be processed is highly redundant and of dubious accuracy; and the problem is to obtain a statistical evaluation, an overall picture, correlation items of mutual significance, singling out new or highly important developments, and storing accumulated results in such a way as to ensure ease of reference, and later correlation with newly acquired data.

Simulators

An area of computing equipment almost unique to military applications is the field of simulators. These may range from a training device for aircrews to familiarize them with a new aircraft, to a system for testing the efficiency of a particular approach to a naval engagement. In order to obtain any degree of sophistication, a simulator necessarily includes extensive computing facilities (analog or digital) linked with a large variety of analog equipment representative of typical input data, and presenting to the observer's eye and other senses typical "operational conditions."

With the advent of space vehicles, a new need is becoming apparent. If manned rockets and satellites are to be used efficiently, experience in their operation can only be gained from simulators, more comprehensive and complex than any thus far contemplated. Expensive though they may be, there is no alternative except risking the loss of the spaceship itself, in the hands of its untrained crew.

Compatibility and Code Conversion

A prime requirement in all computing and data processing activities, that of achieving compatibility between widely differing items of equipment, acquires greater emphasis in dealing with the armed services. Different services, or different departments of the same service, have initially obtained computers from various manufacturers to meet their individual requirements. In order to correlate the tremendous number of records thus produced, without the necessity of referring to the original raw data (if available), it is essential that any central processing agency be able to handle a wide variety of codes and formats, or else that equipment be provided to convert these into standardized form for correlation and evaluation.

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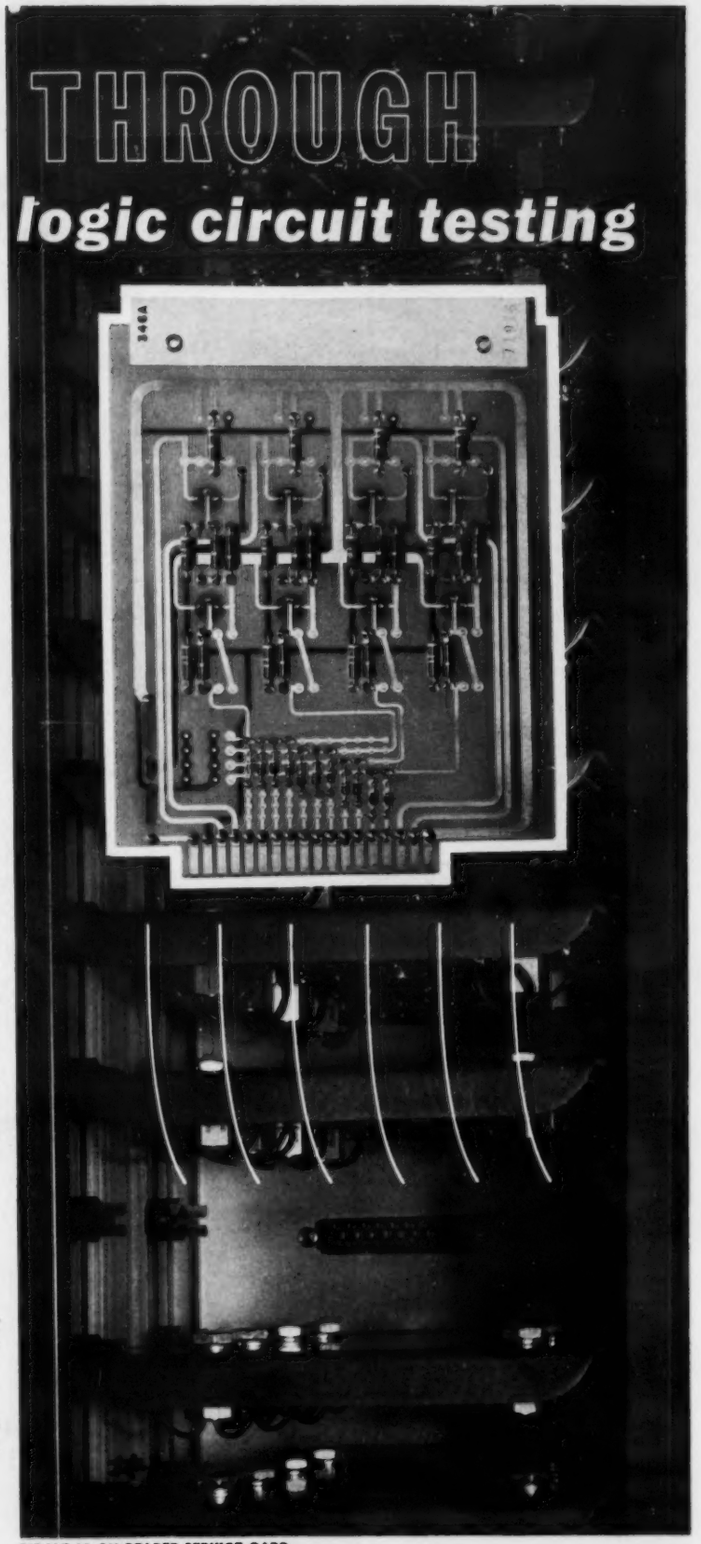

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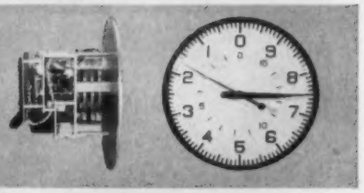

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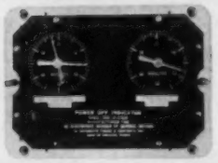

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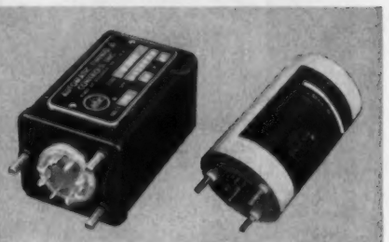

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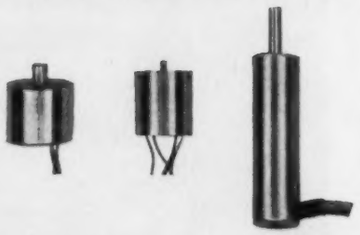

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Binistor is Compact Switch/Memory Element

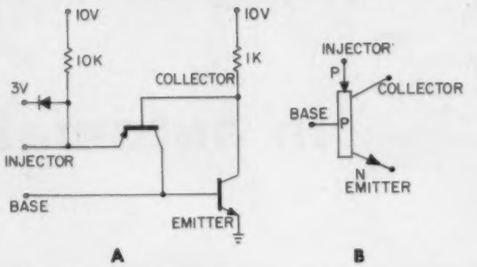

FIG. 1. TWO TRANSISTOR circuit (A) is equivalent to binistor (B).

Of the many types of four-layer semi-conductor devices available for switching and memory circuits, the binistor represents a new mode of operation offering many advantages. The negative resistance characteristics, usually determined by internal parameters in conventional four-layer devices, are, in the binistor, determined by the external circuitry. This results in stable operation over wide temperature limits.

As an example in binistor design, the following circuit description of a binistor ring counter is provided by the Transitron Electronic Corporation, Wakefield, Mass., who introduced the binistor only a few months ago.

Operation of the Binistor Ring Counter

The binistor is a silicon NPN tetrode having four layers and four terminals. Binistor action can best be understood by referring to the two-transistor equivalent circuit shown connected in a typical bistable configuration (Fig. 1). Insertion of base current causes a regenerative action as soon as the collector voltage falls below the injector clamp voltage. The binistor then turns "on" and no further base current is required. A typical collector current in the "on" state will be 10ma and typical injector current is 1ma.

By diverting the injector current the binistor can be switched "off" with a current gain of about 10.

A binistor ring counter used by Transitron in test equipment is shown in Fig. 2. When the power supply is switched "on" it is assumed that one binistor is in the "on" state (Bi 1, for example) and all other binistors are in the "off" state. The transistor Q1 is normally "off" and the injector current for Bi 1 flows through R1. When a positive pulse is applied to the base of the transistor, this transistor switches "on" and diverts the injector current away from Bi 1, thus switching it "off." The positive transient resulting at the collector is passed via the 5k resistor and 2000pf capacitor to the base of the succeeding stage. When the transistor is switched "off" again and injector current becomes available the positive voltage existing at the base of Bi 2 causes it to switch "on," the first binistor remaining "off." The "on" state has, therefore, been passed from one stage to the next at a

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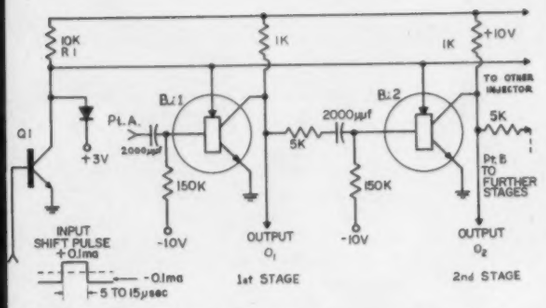

FIG. 2. BINISTOR CIRCUIT is example of simplification. In Ring Counter the ON stage is propagated to next stage by input shift pulse.

rate dependent upon the rate at which the transistor is triggered.

Connecting the binistor stages in a ring (Point A to point B) causes the "on" state to circulate round the loop producing the well known ring counter. Output can be taken from the collector terminal of any binistor collector, as shown.

Other Applications

Typical applications include ring counters, binary counter, shaft registers, core store equavalents and general purpose switching circuits.

The ring counter, and many other simple circuits have been built by engineers only briefed on binistor parameters.

One application that may prove very important is the use of simple binistor stages as elements of a non-destructive memory. Although magnetic devices are far more economic for large capacity memories, the driving, sampling, regenerating, checking, strobing, regulating and amplifying circuits required make small magnetic memories very unwieldy and costly per bit. The transistor flip-flop's complexity, cost and size make reasonably high-density storage very difficult. The binistor may be very useful in this application.

Binistor Compared with Flip-Flop

Comparing a binistor stage with a transistor flip-flop; a flip-flop requires at least two transistors, 7 resistors, 2 capacitors, 2 diodes, for a total of 28 solder connections. High-speed, carefully-designed flip-flops usually require far more components. A binistor stage requires only one binistor and three resistors, for a total of ten solder connections. This simplicity results in far less "deck space." Also, the manufacturing effort is simplified and reliability enhanced. Another important factor: While a flip-flop has the advantage of two outputs and two inputs, it does have commutating and coupling problems.

The speed of the first commercial binistor is adequate for general purpose switching circuit needs. New models of the binistor designed to meet varied requirements of speed, power handling, polarity and size, are in development.

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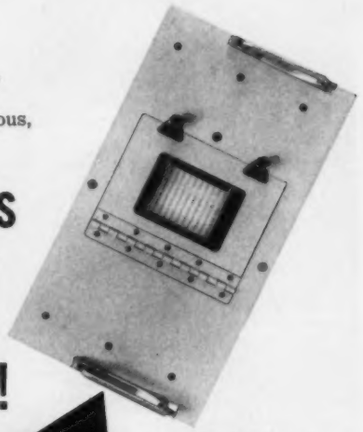

Clary Model 2000 Series Printer

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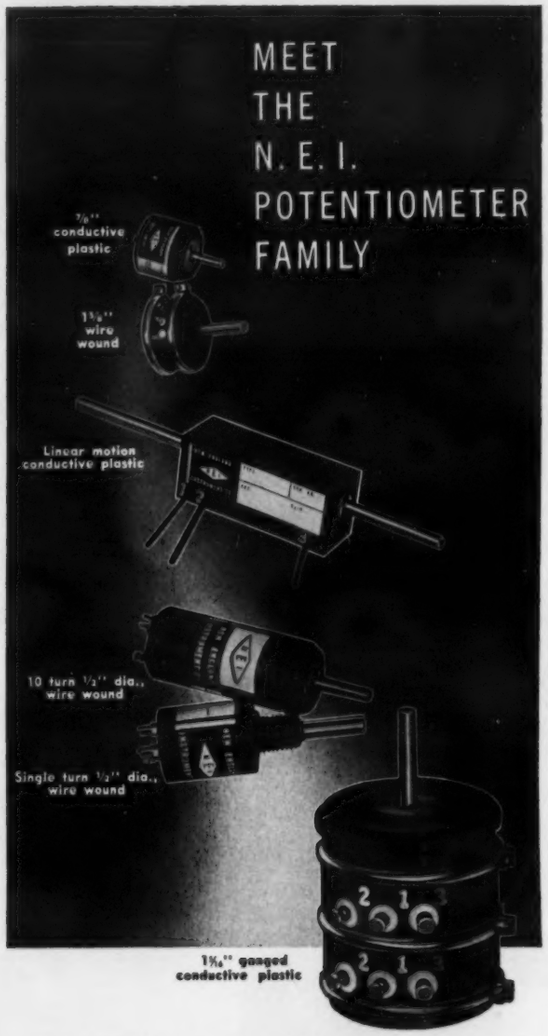

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- Meet performance specs of MIL5272A, NAS710 and applicable portions of JANR-19
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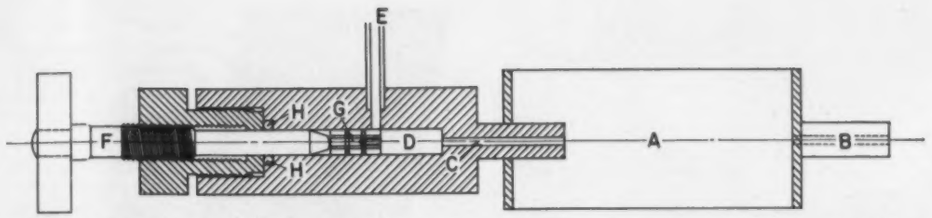


VARIABLE LEAK consists of Chamber A filled with air at 1 Atm. Tube B is sealed with solder before leak is immersed. Leak path is through asbestos packing (D) under compression between porous plug (G) and screw (F). Packing ring (H) ensures against escape of air other than through E. When adjusted for minimum detectable leak, (B) is opened to atmosphere, and tube (E) is sealed to evacuated tube into which leakage is accurately measured using a micromanometer.

Leak-Detection Techniques

H. S. SCHEFFLER
EUGENE N. WYLER
Battelle Memorial Institute

Results of an investigation of various leak-test techniques.

SEVERAL LEAK-TESTING techniques are employed by the electronics industry for checking the leak-tight integrity of hermetic seals used in electronic parts and components. These leak-testing techniques range from a simple bubble test in heated water to comparatively complex tests with a mass spectrometer. It should be obvious that each leak-test technique will have a different sensitivity for detecting leaks.

In keeping with the desire for standardization and a standard method for detecting a leak, the U. S. Army Signal Equipment Support Agency sponsored a program at Battelle for the purpose of investigating the relative merits of the various leak tests employed by industry (under Contract Number DA-36-039-SC-73212).

There are two main categories for leak tests—commercial leak-detection equipment, usually gas detective, and "companies own" leak tests, usually a bubble test.

Bubble Tests

Various types of bubble tests are presently in use—five of the more widely used were chosen for

TABLE 1—EFFECTIVENESS OF BUBBLE LEAK TESTS

Description of Test			Resistors (Horizontal)		Switches		Minimum Bubble Load Rates
Bath	Temperature of Bath	Pressure Above Bath	Definite Failures	Possible Failures	Definite Failures	Possible Failures	Measured Against Micromanometer
Silicone Oil (20 centistokes)	Room	1.5" Hg	21	1	7	—	5.85×10^{-7}
Silicone Oil (20 centistokes)	150°C	1 Atm.	10	0	4	2	4.61×10^{-6}
Tap Water	90°C	1 Atm.	5	0	2	4	3.67×10^{-4}
Tap Water	Room	2" Hg	5	1	2	4	3.12×10^{-5}
Mineral Oil (ASTM 170-180 sec.)	125°C	1 Atm.	15	1	6	0	1.67×10^{-6}
Alcohol (Methanol)	Room	1.5" Hg	19	0	5	2	2.0×10^{-5}
Water With Wetting Agent (Calgon)	Room	2" Hg	8	4	4	2	Too large for micromanometer

evaluation.

Tests were performed on various components either by preheating the bath and immersing the component in it, or by immersing the component in the bath at room temperature and drawing a vacuum above it. In either, the pressure differential between the interior of the component (assumed to be at atmospheric conditions) and the surface of the bath causes flow of air through any defect in the component (if one exists) outward from the component, thus creating bubbles in the bath. It is the ease with which these bubbles may be detected by sight which differentiates one type of bath and test from another. A total of seven tests were performed on various samples, utilizing five different baths. These tests are listed in the first six columns of Table 1.

Thirty-two resistors were subjected to each of the seven bubble tests with resistors first in horizontal and then in vertical position. The resistors were watched for indications of leakage. The time of immersion was one minute.

Seven sealed switches, whose leak rates were measured with a helium leak detector also were subjected to the bubble tests. The measured leak rates were from 2.6×10^{-7} to 1.12×10^{-4} cc-atm/sec.

The number of "definite failures" (components which emitted a steady stream of bubbles in the bath) and "possible failures" (components which gave some indications of being leakers) was tabulated (Table 1).

A "variable leak," designed and constructed at Battelle, was used to get the approximate sensitivity of each leak test. This "variable leak" (see Figure) was adjusted so that the bubbles rising to the surface of the bath were barely discernable. Then a true measurement of the leak rate was made by using a micromanometer in a vacuum system (seventh column, Table 1). Note from these results that a wide variation of sensitivities exist, with the silicone oil bath in an evacuated chamber being the best test of the group. The discrepancies that exist between this test and other results in the table can be attributed to human error.

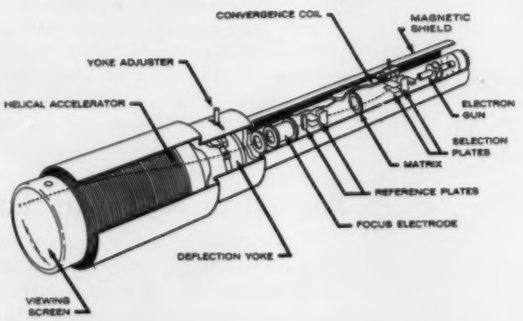
There is no doubt that the silicone oil bath in an evacuated chamber is the best test of the group evaluated. However, there may be cases where it would not be advisable to use this test. It is necessary to place the bath and component in a chamber and evacuate the chamber to 1.5 inches of mercury in order to perform this test. After the test, it is necessary to return the chamber to atmospheric conditions before removing the component. The time factor necessary to perform this test may be a significant cost factor, making the test uneconomical.

For large-volume low-cost production items, the best test to use would be a heated bath type of test which reduces the time of leak testing considerably. The mineral oil that was used in the evaluations is the best fluid of the ones tested for the heated-bath-type test. This bath was also superior

How the CHARACTRON® Shaped-Beam Tube achieves writing speeds of 20,000 high-resolution characters a second

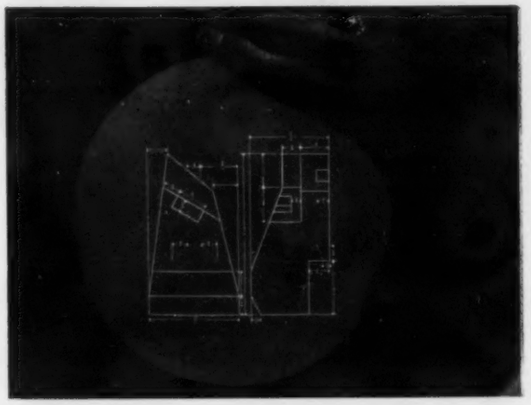
Ten years ago a small group of engineers mated the cathode-ray tube and the Magic Lantern to create a new device with almost unlimited possibilities for precision high-speed display. Systematic improvement and refinement over the past decade have created a new industry around items which were once laboratory curiosities. Today's CHARACTRON Shaped-Beam Tube, in a variety of types and sizes, is incorporated into high-speed microfilm recorders, electrostatic printers for computer data readout, and many visual situation display systems.

Among several inherent advantages of the CHARACTRON Shaped-Beam Tube is the instantaneous generation of the most complex alphanumeric characters and symbols. Character formation and generation time is not related to character complexity, as is the case with other methods. High resolution and very high speed are achieved by the beam forming and deflection methods. Characters from .75 inches to .02 inches with brightness and clarity are obtained at rates up to 20,000 characters per second.



The fundamentals of operation are basically simple. As in more conventional cathode-ray tubes, a beam of electrons is generated in an electron gun, accelerated, and introduced into a field between co-planar electrostatic plates. A special element, called the "matrix," is located at a precise distance beyond the deflection plates. The matrix is a thin beryllium-copper disc centered on the electron gun axis at right angles to the beam. Commonly, sixty-four minute characters in an 8 x 8 array are precision etched through the matrix disc. This permits selection of any character with a six-bit binary code. (Up to 256 characters have been provided for special applications.)

Applying a voltage to the deflection plates positions the electron beam at any given place on the matrix. The beam then passes through the character-shaped stencil and is returned either magnetically or by means of an electrostatic lens to the tube axis. Post-matrix reference plates and/or magnetic deflection are then employed to position the shaped beam at any desired position on the tube face.



CHARACTRON Shaped-Beam Tubes range in size from 1" x 3" rectangulars through 5", 7", 12", 19", to 21" in standard round types, with non-standard sizes available on a custom basis. Production types for slow-speed, high-speed, small-character, large-character, and variable-size character are provided off-the-shelf, depending on application and requirements. In addition to character display modes of operation, the tubes' special capabilities include line and Lissajous-figure drawing, graphical plotting, and even mechanical drawing with variable line weight for dimension and extension lines.

The cost per character of the CHARACTRON Shaped-Beam Tube in a computer readout system is less than any other comparable display device. You are invited to write for complete technical information to General Dynamics/Electronics, Information Technology Division, Dept. B-29, Post Office Box 2449, San Diego 12, California.

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to several of the vacuum-type tests.

Commercial Leak Test Apparatus

Commercial equipment has a much larger initial expense than a bubble test and is readily suited to the testing of only a limited number of component types. It has a sensitivity in the range of 10^{-9} cc-atm/sec. This is better than most bubble tests by a factor of between 10^2 and 10^4.

A mass spectrometer is the most popular piece of commercial equipment that is used for leak detection. The majority of these devices use helium as the detection gas. There are many ways to use the mass spectrometer as a leak-detection device, but the best way from the standpoint of reliability, time, and expense is to check the components after they have been backfilled with helium gas and sealed off. In this manner, the completed component is checked, and not one that still has an evacuation tube open which must be pinched off and sealed. In the past, components like resistors were not easily or economically adaptable to such a method of testing, but recent innovations in the field have made this possible.

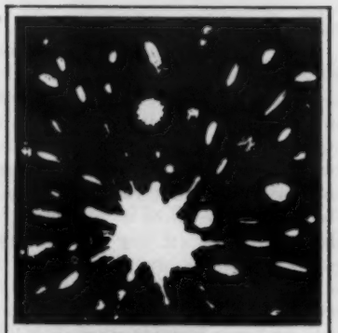
A mass spectrometer is superior to a bubble test in various ways—(1) the criteria for failure is set electronically and not left to the discretion of the operator, (2) the sensitivity of a mass spectrometer is much greater than that of a bubble test, and (3) the mass spectrometer can be set up to perform the leak tests automatically. The major drawback to this method is the expense. Methods using gases other than helium are presently available. Some use the halogens, while still another uses radioactive krypton.

Additional work should be done in standardizing leak tests throughout industry. It is also possible that the application of a particular component may require it to have a leakage rate less than can be presently measured. Not until standards are clearly defined can the field of leak detection eliminate its troublesome areas, and make the progress demanded by new developments in the electronic industry.

Acoustics Analysis Laboratory

Rotron's new Acoustics Laboratory is equipped to measure, record and publish data defining the acoustical characteristics of all air-moving devices manufactured by the Company. Such data is published in the form of product curves where values of sound pressure level in decibels are plotted against octave bands ranging from 20 to 15,000 cps. These individual curves are then related to the Noise Criterion (NC) Curves to show the degree to which, and the frequency at which, the product will stay within the limits of these standard curves. During measurement the fan or blower is discharging into a controllable enclosure simulating actual field operation. Unless otherwise required, these noise tests are run when the fan is operating at its best-efficiency point . . . (*From news release, Rotron Mfg. Co., Inc., Woodstock, N. Y.*)

FOR MORE INFORMATION CIRCLE 129 ON READER-SERVICE CARD



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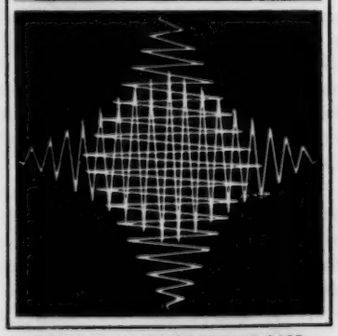


CIRCLE 37 ON READER-SERVICE CARD

Decision Threshold Computer Provides FSK Diversity

Frequency shift keying increasingly used in radio telegraph and data transmissions, results in the coding of a binary "1" or a mark for transmission on one frequency while a "O" or space is transmitted on an adjacent frequency. Received signals are separated according to frequency by parallel filters, then passed to a decision circuit, which decides whether a mark or space was most probably transmitted. This is conventionally done by arranging for a negative for a negative output from the mark, a positive output from the space, and combining the two. If the sum is nega-

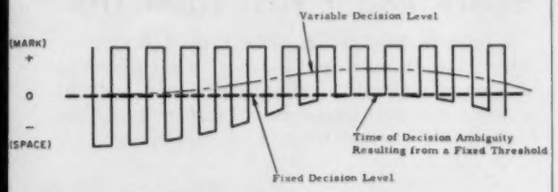


FIG. 1. DECISION THRESHOLD effects for selectively fading FSK signals.

tive, the decision circuit calls it a mark; if the sum is positive, it is called a space.

When the transmitted signal is subject to deep fades on either the mark or space channel, but not on both, this method leads to an ambiguity which is easily remedied by the use of a new Decision Threshold Computer (DTC) recently developed by Page Communications Engineers, Inc., 2001 Wisconsin Avenue, N.W., Washington 7, D.C., a Northrop Corporation subsidiary.

The new DTC makes the use of a variable decision

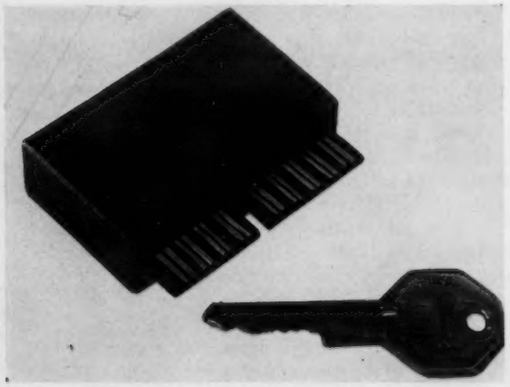


FIG. 2. DECISION Threshold Computer circuitry occupies little space and weight, can be added to existing FSK systems.

level, rather than a fixed zero level. Under this system, the sudden absence of a mark signal is interpreted as a space—and vice versa—as long as either signal is present in a detectible amount (Fig. 1). In effect, the DTC provides a diversity improvement, even when used on a single receiver.

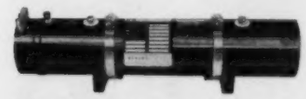
Because simultaneous fading in both mark and

1 kw Hughes traveling wave tubes in S-Band

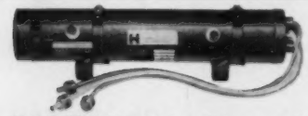
Now available in production quantities, these new and improved tubes offer you 1 kw of pulsed output power, with low power input, minimum heat generation and high reliability.

All these Hughes S-band tubes are lightweight, compact and ruggedly built to withstand the most severe environmental conditions—and provide long life. Each has been fully tested in the field.

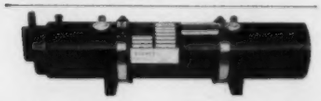
Three of these tubes provide full octave frequency ranges of 2.0 to 4.0 kmc and you have a choice of either ½ or 1% duty, in either ungridded or gridded versions, and with gains up to 37 db. All are permanent magnet periodically focused.



311H Gridded, 1 kw minimum peak power output, 1% duty, 36 db small signal gain @ 50 mw input. Weight: 13 lbs. Length: 17-7/16". Meets usual customer requirements of MIL-E-5400, Class I environmental tests.



312H Gridded 1 kw minimum peak power output, ½% duty, 36 db small signal gain @ 50 mw input. Weight: 11 lbs. Length: 15-3/8". Meets usual customer requirements of MIL-E-5400, Class I environmental tests.



304H Ungridded, 1 kw minimum peak power output, 1% duty, 37 db small signal gain @ 1 mw input. Weight: 12½ lbs. Length: 17-31/32". Meets usual customer requirements of MIL-E-5400, Class I environmental tests.

313H Ungridded, 1 kw minimum peak power output over the center portion of the band, ½% duty, 36 db small signal gain @ 1 mw input. Weight: 17½ lbs. Length: 16-5/8". Meets usual customer requirements of MIL-E-1 environmental tests.

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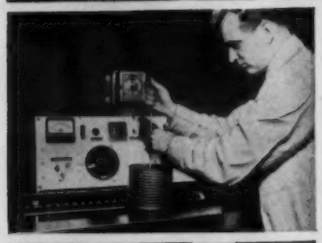

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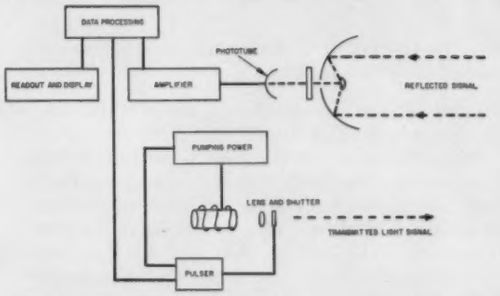
space channels seldom occurs, an improvement of the received signal-to-noise ratio of from 10 to 20 db at a probability of binary error in 1 to 10^4 bits has been achieved through the use of the new device.

Development of the Decision Threshold Computer, which takes the form of a small potted circuit about the size of a package of cigarettes (Fig. 2), has been accomplished by Page Communications Engineers, Inc., for use on HF and VHF data communications systems. Presently being used on NATO and Pacific Scatter systems, designed and built by Page, the DTC technique also has possible applications in other digital systems.

FOR MORE INFORMATION CIRCLE 130 ON READER-SERVICE CARD

Space Radar First Laser Use

A coherent light radar, called COLIDAR, for Coherent Light Detection and Ranging, marks something of a record in rapid application of a new scientific principle. Designed for use aboard craft ranging outer space, it is said to have inherent low weight, low power



requirements and small size, making its use in spacecraft practical.

The laser, or optical maser, principle was first announced by scientists of the Hughes Aircraft Company in July 1960. Only seven months later a practical detection and ranging device using the narrow light beam made possible by the laser principle has been announced by the same scientists.

Operation of the Colidar is shown in the block diagram. The *laser* light source is depicted as a cylinder wound by a spiral. The central core of the laser is a ruby crystal $\frac{3}{8}$" in diameter and $1\frac{1}{2}$" long. A spiral flash tube surrounding the crystal supplies pumping energy, causing light amplification by stimulated emission of electrons within the ruby.

The amplified light builds up to a pulse which escapes as an intense burst of red light through one end of the ruby which is more thinly silvered than the other. As the transmitted pulse emerges it trips a timing circuit to measure the time required for any reflected light pulse to return from the target.

The output of the laser is a pulse of in-phase, single-frequency vibrations capable of being focussed into a very narrow beam. Because of this coherent characteristic, the light from the laser enables ranging on objects having 10% reflectivity up to 10,000 yards in clear atmosphere. In the absence of atmosphere the range of the Colidar is expected to be hundreds of miles.

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The ASW Electronics Market

The Western Allies control about 95% of the world's shipping.

The Western Alliance basic path of communications is the high seas.

Nearly three-fourths of the earth's surface is ocean.

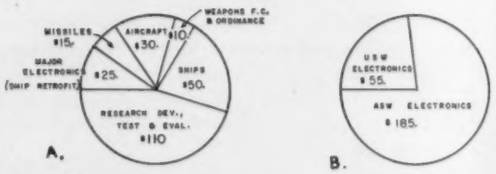
The USSR has about 450 submarines.

These four facts show why antisubmarine warfare is important to the free world and the United States, and why it is a major concern of the U. S. Navy.

Electronic equipment is vital to the following elements of undersea warfare:

1. Detection, classification, or identification of submarines and underwater weapons, including mines.
2. Control of underwater weapons (submerged phase only for Polaris).
3. Guidance and electric propulsion of underwater weapons and auxiliary vehicles.
4. Underwater ECM and simulators.
5. Underwater communication and communication through the air-sea interface.
6. Oceanographic exploration and measurements.
7. Arming and disposal of mines.

It will be noted that the above does not include a large amount of shipboard and aircraft electronic equipment involved in air defense, navigation and control of the ship or aircraft as a vehicle, and in other non ASW/USW missions.



ESTIMATES of FY '61 electronics procurements in USW/ASW categories. (A) USW/ASW procurements totalling $240 million are classified by probable distribution. (B) Bulk of total will go to ASW. Amounts on graphs indicate millions of dollars.*

Estimates of ASW/USW funds to be expended for electronics in FY 1961 add to a grand total of approximately $240 million. Of this amount approximately $110 million is earmarked for Research, Development, Test and Evaluation of new ASW detection and localization methods, activities which have been accorded the most urgent priorities. Of the total amount, the percentage devoted to ASW is approximately 85%, or $185 million.

Some Major ASW Programs

Present vehicles on platforms for ASW generally have disadvantages of range or cost. In searching for a new platform, particularly in view of the block-obsolescence of the destroyer fleet in the mid-1960's, the Navy has funded the construction of a hydrofoil,

*From a study by the ASW Task Force of the Military Marketing Data Committee, Electronic Industries Association.

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	Model 928	Model 928/2
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Deviation	to 400 kc	to 150kc
Modulation	50cps-120kc	50cps-120kc
Construction	Shock Resistant, ruggedized, waterproof.	
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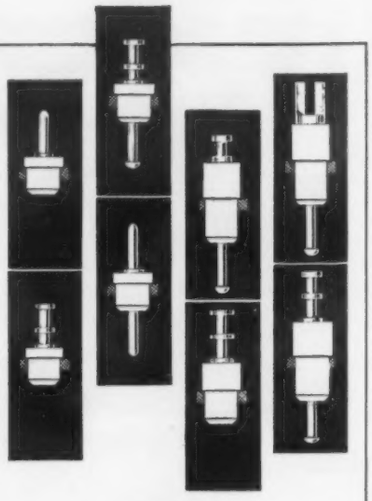
TAURUS TERMINALS OF TEFLON*



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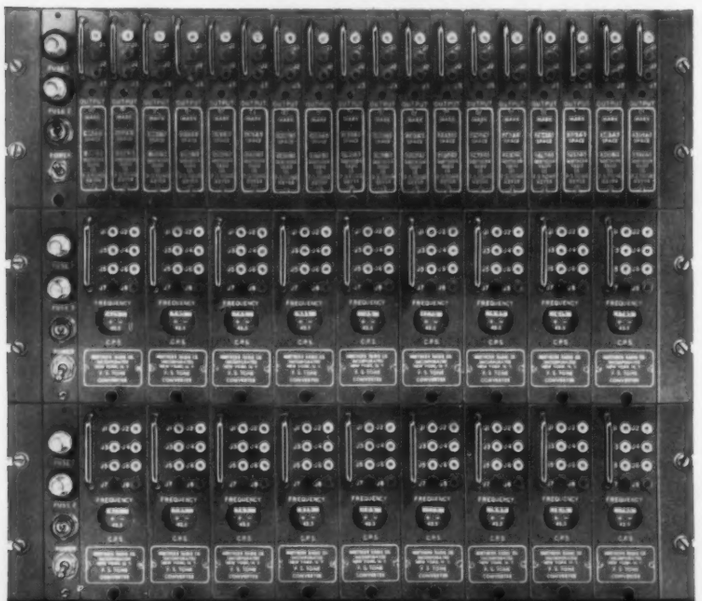

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PC(H). Theoretically, the hydrofoil could provide the speed desired at low cost with moderate ranges, but tests are necessary to determine whether the craft can operate effectively in all sea states. Hydrofoil platforms appear to offer a major area for technological breakthrough.

Opportunities in the key RDT&E area of detection and classification will be concentrated in better sensors, improved data processing, and command and decision-making equipment. Other areas where electronics can make major contributions are underwater and interface communications, training devices and simulators, countermeasures and decoys.

Because of the nature of the ASW problem, a trend toward integrated systems, comparable to that experienced in the missile and aircraft markets, is not anticipated in the forseeable future. Also, because of the number of merchant ships, warships, submarines and aircraft susceptible to the use of improved ASW devices, particularly more sensitive sensors, this market contains within itself an almost explosive potential for growth. Certainly any industrial organization that can develop advanced equipment that materially improves Navy ASW capabilities will have no difficulty selling the equipment.

Code names for some ASW projects frequently mentioned in news reports follow with brief descriptions:

ASROC—ASROC is a rocket torpedo to be fired from surface vessels which will home on underwater targets. It is due to become operational in 1961.

ARTEMIS—This project explored the development of a submarine detection system for fixed, deep water, long range use.

ATLANTIS—This project (1959) studied the feasibility of large ocean surveillance systems.

DASH—A surface ship drone antisubmarine helicopter system for delivery of a weapon to the location of the submarine.

JEZEBEL—In this system, passive sonobuoys are dropped in a pattern from a search ship or aircraft. Sonobuoy findings are transmitted by radio to search vehicles for localization.

JULIE—Explosive charges released from buoys provide an echo receipt upon reflection from submerged submarines. Time and depth of echo determine distance from buoy. Echo circles from two or more buoys intersect to show target location. The technique is referred to as EER, or "explosive echo ranging." Its advantage is long range.

LULU—Airborne nuclear depth charge.

MAD—Magnetic Anomaly Detection (MAD) gear has been installed in 800 aircraft by Grumman since 1953. The devices detect changes locally in the earth's magnetic field caused by a submerged submarine.

MAD's advantages are positive classification and invulnerability to jamming. It's limitation is short range.

MK-37-1—This is a surface and submarine guided antisubmarine torpedo.

MK-46—A lightweight, high-speed, homing antisubmarine torpedo.

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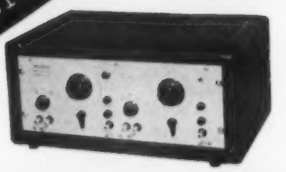

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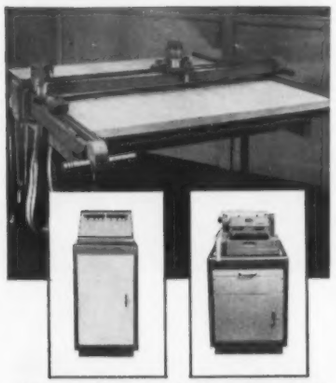

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NOW! Direct numeric indication *or* printed output (left inset)—automatically derived from point positions to within .0015"

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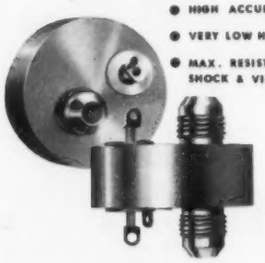
CIRCLE 46 ON READER-SERVICE CARD

REC's 800 SERIES, PRESSURE TRANSDUCERS

Features

- FAST RESPONSE
- HIGH ACCURACY
- VERY LOW HYSTERESIS
- MAX. RESISTANCE SHOCK & VIBRATION



Model 800C

REC's Model 800C Capacitance Type Pressure Sensor utilizes a free-edged, circular diaphragm of Ni-Span C. Full scale ranges are from 1 to 100 psi and differential or absolute pressure measurements can be made.

The 15 psi range features 100 percent overpressure, no resonances less than 2500 cps, and a pneumatic greater than .004 seconds. Maximum excitation voltage is 110 V rms and the capacity ratio change is such as to directly produce an output equal to 25 percent of this voltage.

Write for Bulletin No. 36010

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SNIFFER GEAR—Also known as odiferous homing, sniffer gear picks up ionization traces left in the atmosphere by a snorkeling submarine. Sniffer has shown good reults in ASW exercises.

SONAR—The principal means of detection in the ocean has been (and probably will remain) sound apparatus, because water is relatively opaque to light or radio waves. Active sonar emits a sound signal and detects its return from a reflecting object. Passive sonar is strictly a listening device which sends no signal of its own but depends up on sound emissions from the target. Variable depth sonar is towed by a destroyer and its depth controlled by varying the length of cable. SQS-26 sonor is a large, high-powered, low-frequency sonar for surface ships.

SUBIC—A study of submarine integrated control systems.

SUBROC—This weapon is a rocket torpedo launched from a submarine to intercept another submarine.

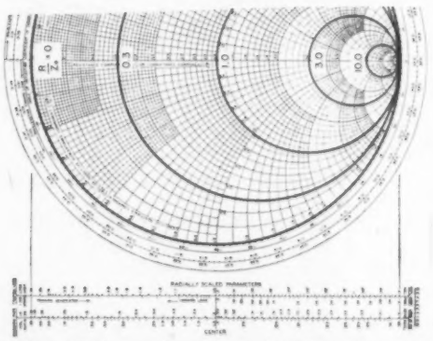
SURIC—A study of surface ship integrated control systems.

THRESHER—An antisubmarine nuclear submarine.

TRIDENT—This project is to gather experimental evidence on the validity of the ATLANTIS study.

The Smith Chart

The Smith Chart is just as important a tool for determining characteristics of a waveguide system as are the various equipment items used to measure frequency, attenuation and standing wave ratio. In fact, because impedance cannot be measured directly, it is only by using the Smith Chart that measurements of Standing Wave Ratio made with a slotted section can be translated into needed information on impedance without resorting to lengthy and laborious calculations.



Developed in the later 1930's by P. H. Smith, the chart is a special kind of impedance co-ordinate system mechanically arranged so that the relationships of impedances can be determined at any point along a transmission line. Only the swr and the positions of the voltage maximum and voltage minimum need be known to make use of the Smith Chart . . . (*From 56-page Application Note 46 which includes sections on Microwave Transmission Theory, Measurements, Experiments, Glossary, Equipment Data Sheets.—Hewlett-Packard Co.*, 1501 *Page Mill Rd., Palo Alto, Calif.*)

FOR THIS LITERATURE CIRCLE 132 ON READER-SERVICE CARD

MINI-RAPID PROCESSOR DEVELOPS DATA DISPLAY FILM RECORDS–FAST!

See your data display film records in minutes. Fairchild Mini-Rapid Film Processors give you automatic delivery of negatives – developed, fixed, washed, dried—commercial quality.

16mm films up to 6 f.p.m.

35mm films up to 4 f.p.m.

Oscillograms, digital or analog display, radar, meters, gauges, controls – any information display that you record on 35 or 16mm film can be read back just a few minutes after your film is inserted into the Mini-Rapid.

Operation? Easy. Insert a few inches of film into the loading compartment, drop in spool, close door. Automatic transport takes over and does the rest.

Write for illustrated specifications and prices to Industrial Products Division, Dept. MS-4, Fairchild Camera and Instrument Corp., 580 Midland Ave., Yonkers, N. Y.

MINI-RAPID FEATURES

- capacity up to 400 feet
- table top compactness
- dual thermostat control
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- leaderless daylight loading
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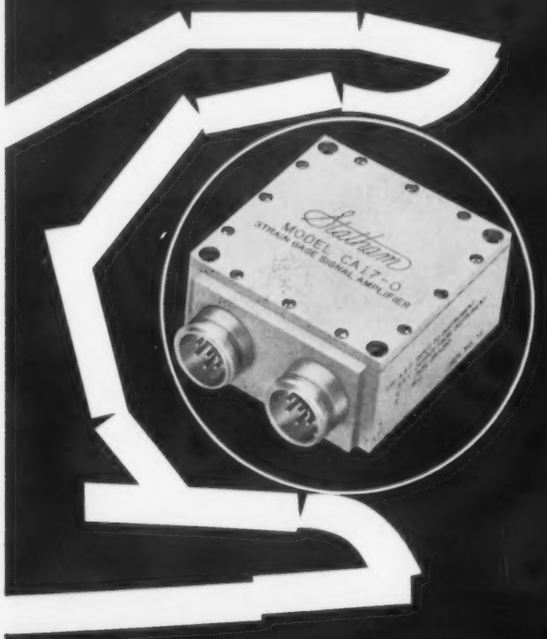

DESIGN FEATURE:

Drastically reduced in size, the CA17 carrier amplifier provides for total utilization of low-level signals . . . proves itself more reliable in adverse environments than larger and heavier amplifiers . . . assures the precision required in aircraft and space vehicles. The CA17 may be used with any resistance strain gage transducer. *Excitation:* 28V d.c. ± 5% @ 30ma, including built-in transducer power supply. *Output:* 0-5 Volts d.c.

Statham

ED

ELECTRONICS DIVISION

Statham
Instruments, Inc.
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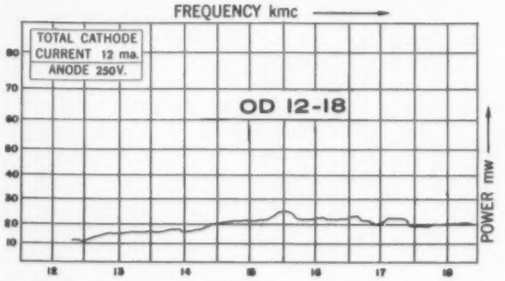
CIRCLE 49 ON READER-SERVICE CARD

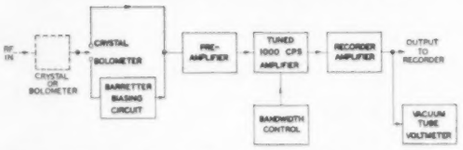
Backward Wave Oscillators



Because of their wide-band, electronic tunability characteristics, Stewart backward wave oscillators serve as an excellent source of microwave signals for a wide variety of applications. In microwave swept signal generators, for example, they permit analysis of microwave components in minimum time. Similarly, their use is highly effective in receiving and transmitting equipment requiring rapid programmed swept signal excursions . . . The tubes are high vacuum, hard glass and metal, helix-type backward wave oscillators. Key to their dependable, uniformly reproducible performance characteristics is their precision lens systems for forming a hollow electron beam, their extremely accurate helix pitch and placement relative to the beam, and the unparalleled care with which they are manufactured and processed . . . (*From 6-page brochure, Stewart Engineering Corp., Santa Cruz, Calif.*)

FOR THIS LITERATURE CIRCLE 133 ON READER-SERVICE CARD

Video Crystal Receiver

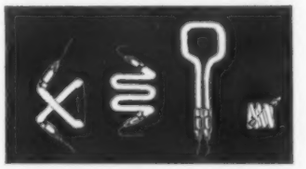


To overcome the difficulties previously associated with square-law crystal detectors and to fully exploit their inherent sensitivity, Weinschel Engineering developed the BA-7 receiver, shown in block diagram . . . Significant features of this instrument include high gain and an input circuit designed specifically for the impedance and dynamic voltage range of video crystal detectors. True square-law conformity is insured by the simple expedient of limiting the range of the amplifier gain control so that, even at minimum gain control setting, the amplifier output will be driven to saturation before the crystal departs significantly from its square-law response curve. A dynamic range of 40 db, the usual requirement for antenna pattern measurements, is achieved by reducing the noise with a unique, narrow band filter; accuracy is not compromised, being about 0.1 db per 10 db of dynamic range. Sensitivity, the most important reason for considering the video crystal receiver, is in the order of 10^{-11} watt . . . (*From 12-page Application Note 5, Weinschel Engineering, Kensington, Md.*)

FOR THIS LITERATURE CIRCLE 358 ON READER-SERVICE CARD

CUSTOM BUILT LIGHT SOURCES
from

ARISTO



- Aristo sources can be built to any size, shape and color to your specifications.
- EFFICIENCY: High—80 to 120 Lumens per watt
- TUBE TEMPERATURE—Cool—100-120°F
- Long Life—Simple installation
- An Aristo custom source may be the simple solution to that tough illumination problem

Another Aristo Product:

MIC-O-LITE for Shadowless Illumination in

- Inspection
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Mic-o-Lite is a cold light source designed especially to produce "shadowless" illumination on small objects, parts or specimens. It is an ideal source for visual inspection under magnification, but is primarily designed for low power microscopic inspection and photography in the industrial, scientific and research fields.

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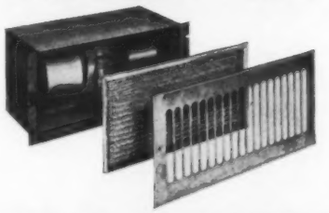
McLEAN



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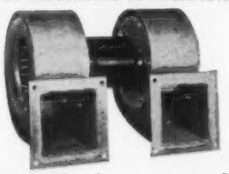

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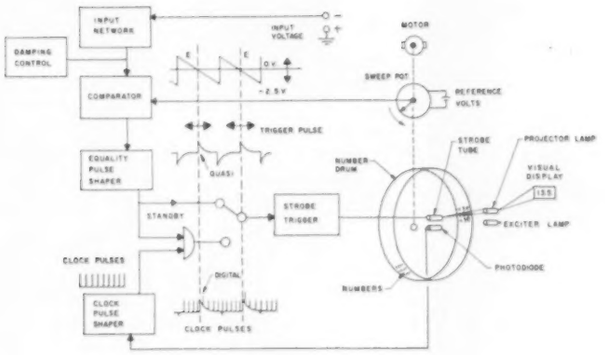
CIRCLE 51 ON READER-SERVICE CARD

MILITARY SYSTEMS DESIGN

Digital Voltmeter Uses Strobed Drum And Conductive Plastic Potentiometer



ROTATING NUMBER Drum is coupled to conductive plastic potentiometer in new stroboscopic digital voltmeter. Block diagram shows how sawtooth standard voltage is compared with input voltage to trigger strobe light when voltages are equal.

A UNIQUE electromechanical-optical system combines stroboscopic readout techniques with the long life and high accuracy of a conductive plastic potentiometer in this economical digital voltmeter. The DVM has an accuracy of 0.4%.

Heart of the instrument is a number drum, rotating continuously at high speed, which is coupled directly to a linear rotary potentiometer that generates a sawtooth sweep voltage.

On the surface of the drum is a film strip containing a row of small holes, each aligned with one of a sequential series of 250 numbers. Holes and numbers are placed at equal intervals on 320° of the drum periphery. The potentiometer, with electrical angle of 320°, is mounted on the same at a nominal speed of 24 revolutions per second by shaft as the drum—both being rotated continuously at a nominal speed of 24 revolutions per second by a small motor.

A light shines through the holes in the film onto a photodiode which feeds a series of clock pulses to a flip-flop—pulses so timed that a strobe lamp, located inside the drum, fires only when a number and a projection lens are properly aligned.

A standard voltage is impressed across the potentiometer, generating a sawtooth or "ramp" voltage for each revolution of the potentiometer (and drum).

The unknown voltage is continually compared, by electronic means, to this sweep voltage; at the instant the two voltages are equal, the flip-flop is triggered so that the next hole coming into alignment causes the strobe lamp to flash. A film strip number is thereby projected through an enlarging lens onto a ground-glass viewing screen on the front of the instrument. Since this comparison is made once for each revolution, the strobe lamp "fixes" or stops the number which corresponds to the unknown voltage.

The 24 images per second create a virtually steady image owing to the persistence of human vision.

Key to the technique is a highly accurate rotary potentiometer capable of withstanding millions of revolutions without deterioration. Wire-bound potentiometers were ruled out because wear caused linearity problems within a relatively short time. The problem was solved by the use of a conductive plastic sweep potentiometer with a hard, smooth and uninterrupted surface of conductive plastic resistance track, along which the precious metal wiper continually travels. The life is 20 to 50 times that previously available. The DVM was checked out successfully after being subjected to life tests of more than 130 million revolutions. The DVM is a product of Electro-Logic Corp., Venice, Calif. The plastic conductive potentiometer used is made by Markite Corp., 155 Waverly Place, New York 14, N. Y.

FOR MORE INFORMATION ON DIGITAL VOLTMETER CIRCLE 134 ON READER-SERVICE CARD

FOR MORE INFORMATION ON CONDUCTIVE PLASTIC POTS CIRCLE 356 ON READER-SERVICE CARD

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...no leakage, even with Helium

Proven reliability of the basic Circle Seal design, supplemented by precision production techniques, have made Circle Seal valves renowned for operational dependability in the most critical aircraft, missile and ground support applications.

200 SERIES CHECK VALVE

- Absolute zero leakage
- 0-3000 psi.
- Low cracking pressure
- Mounting versatility for any application
- Ideal in applications from vacuum to low or high pressure pneumatic or hydraulic systems encompassing the entire range of exotic fuels and oxidizers

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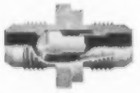
- Low cracking pressure
- Minimum pressure drop
- Unaffected by O-ring swell
- Perfect for applications requiring a combination of low pressure drop and zero leakage



2600 SERIES MINIATURE CHECK VALVE

- Superior performance from 0-3000 psi.
- Leakproof sealing assured by resilient seals
- Minimum size and weight
- Suitable for mounting in any position
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CIRCLE SEAL precision valves

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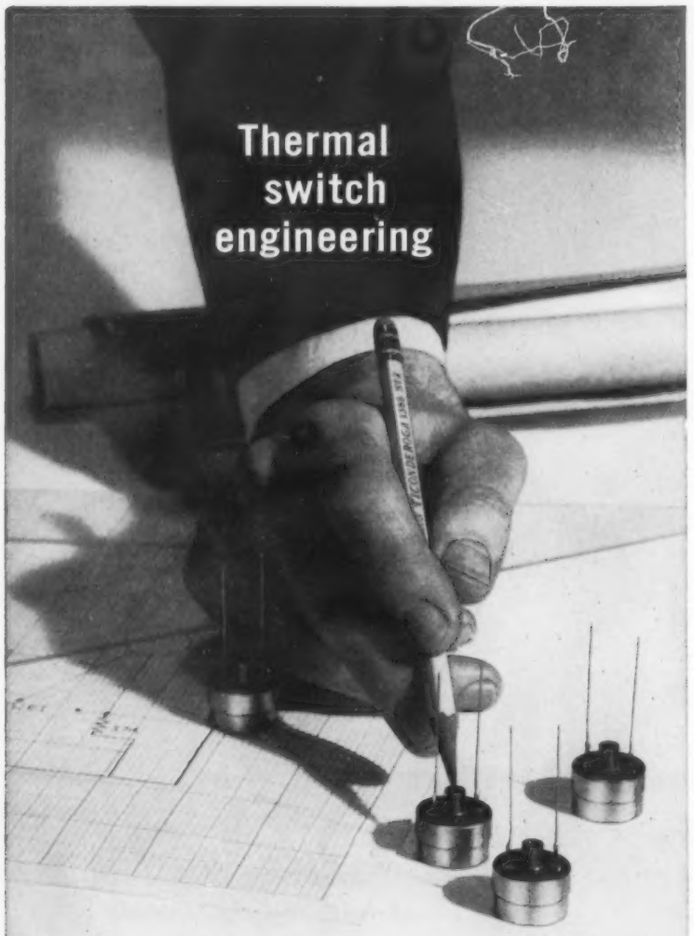
CIRCLE 52 ON READER-SERVICE CARD



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If you are concerned with measurement of surface temperatures in aircraft and airborne electronic equipment in confined spaces, this may be a thermal switch you could use. We designed and manufactured it to meet exacting specifications of a prominent aircraft manufacturer.

Chances are your needs may require modifications or even a completely new switch. We have always realized that there are few "critical" control switches that can be all things to all people. That's why we have the research and development engineers who can and do tackle specific problems of thermal control. Can we help you solve yours?

This new hermetically sealed, bi-metal, single or 2-wire switch has calibration range of -20F to 600F; safe momentary overshoot to 800F; available with various type mountings. When inquiring, mention "button" switch.

CPI

CONTROL PRODUCTS, INC.

274 Ridgedale Avenue, Hanover, N. J.

CIRCLE 53 ON READER-SERVICE CARD

Army Mobile Computers

"FIELDATA" stored digital data processing devices for combat and field use which have been developed under the Army Signal Research and Development Laboratory contracts are exemplified in the New "Basicpac" medium size computer designed and built by the PHILCO Computer Division at Willow Grove, Pa. All "Fieldata" computers use magnetic tape transport systems developed by Ampex.

Basicpac is designed to operate: (1) As a mobile element of an integrated Automatic Data Processing System (Fig. 1) within the U. S. Continental Army Command; (2) as part of an operations center, such as a Corps or Division tachtical operations center or fire directional center; or (3) as a special purpose computer in a larger system, such as a processor in a radar set or weapons system.

"Basicpac" is an asynchronous, binary computer operating at a clock frequency of 1 mc. Six bits, or one alphanumeric character, are operated on and transferred in parallel. Six characters of a 36-bit word are operated on serially. Arithmetic and transfer operations generally require 1 μsec/character or 6 μsec/word. A transfer of control operations takes 16 μsec, including instruction memory access.

Each memory unit is a 4096 word magnetic core array with a 12 μsec cycle. Memory capacity can be expanded up to seven modules with a total storage of 28,672 words.

High-speed inputs and outputs are made possible by the new tape transport system developed for the FIELDATA system by the Ampex Military Products Company of San Carlos, California. The Army de-

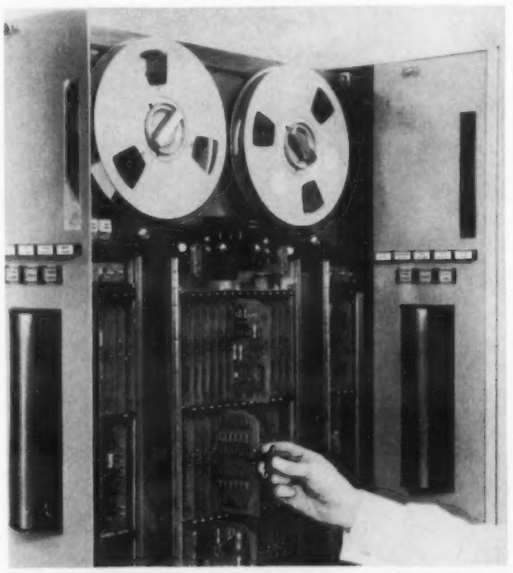

FIG. 1. NEW TAPE TRANSPORTS for Fieldata family of computers features compatibility with both punched card and "on-line" computations; solid-state electronics; and modular etched-circuit construction.

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Model CS-12
for *Constant Current*

- Meter Calibrator
- Precision Current Source
- Transistor and Diode Tester

▸ *High Accuracy* ▸ *Excellent Stability* ▸ *Programmable*

For testing and measurement of transistors, diodes, clutches, solenoids, meters, other current sensitive devices.

- **Current Range is 10μa to 1 amp. with 5 decade selectors.**
- **Regulation 0.002%**
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Literature describing this and other constant current sources from 0.1μa to 30 amp. may be obtained from

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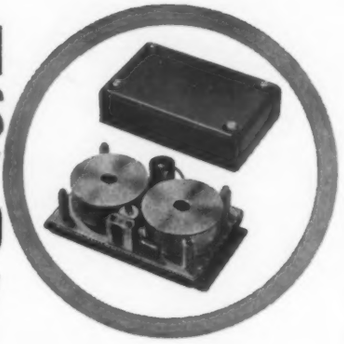
BEATTIE-COLEMAN PROGRAMER OFFERS 99.999% RELIABILITY



4 HOUR PROGRAM ON 13 CHANNELS

Reliability of the Beattie-Coleman MLPR-13 Programer has been thoroughly **proved** in numerous successful missile applications and in rigorous laboratory tests. This precision instrument offers these important features:

- 13 channels.
- Not affected by magnetic fields.
- Controls programs up to 4 hrs. 42 mins. duration.
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- Available in 8 tape speeds.
- Tapes quickly changed for varying programs.
- Compact, light weight.
- Timing accuracy: Repeatability ±0.05%.
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Other models to fit your needs. Write for catalogs.

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DELAYS TO 10,000 usec with ± 1% ACCURACY

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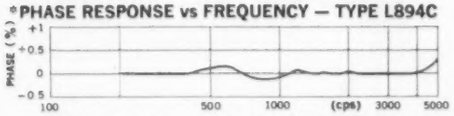
- Weight under 25 lbs.

*PHASE RESPONSE vs FREQUENCY — TYPE L894C



(5000 usec delay, ± 0.1% phase linearity in center band, ± 0.2% to cut-off, rise time: 100 usec)

Columbia Technical's Audio Delay Lines insure unrivalled transmission fidelity. Designed around complex m-derived filter networks, each element is equalized and matched for optimum phase and amplitude response.

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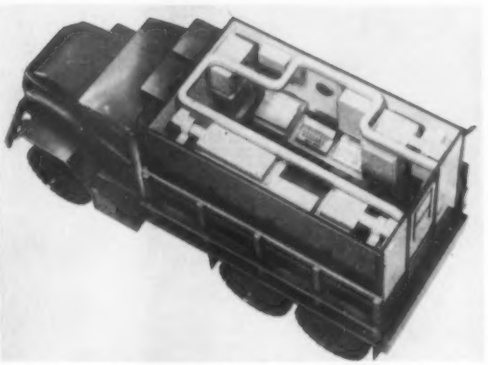

FIG. 2. BASICPAC medium size Army computer can be used as mobile unit or shelter installation, one of the "Fieldata" series of computers, developed under ASRDL contracts.

manded a reliability of 10^{10}, equivalent to approximately only one undetected error per 1000 reels of tape. An error-checking and correcting technique involving seven support channels for seven channels of information, fourteen channels in all on a 1-inch tape, enabled Ampex to achieve this high accuracy even under field and combat conditions.

FOR MORE INFORMATION ON PHILCO COMPUTERS CIRCLE 135

FOR MORE INFORMATION ON AMPEX TAPE TRANSPORTS CIRCLE 136

Static Power Conversion Equipment

Harmonic emf – $e = E_{maximum} \sin \omega t$

Impedance – $Z = R \pm jx$

Inductive Reactance – $X_L = +j\omega L$

Capacitive Reactance – $X_C = -j\frac{1}{\omega C}$

Three-Phase Balanced Wye Load

$E_{line} = \sqrt{3}$ E phase

$I_{line} = I$ phase

Three-Phase Balanced Delta Load

$E_{line} = E$ phase

$I_{line} = \sqrt{3}$ I phase

Balanced Load Power Relationships

Power = $\sqrt{3}\ E_{line}\ I_{line} \cos\theta_{phase}$ (watts)

Power Factor = $\cos\theta_{phase}$

745.7 watts = 1 horsepower

Static power conversion equipment refers to any equipment which converts electrical power from one form to another without the use of moving parts such as rotors or vibrators. "Static" these days implies the use of semi-conductors—and the exclusion of tubes. Typical conversions are: (1) dc to ac (in which case the unit is usually called an inverter, (2) ac of one frequency or phase to ac of another frequency or phase (in which case it is usually called a converter), (3) dc of one voltage to dc of another voltage (converter or power supply). (4) There are many other specialized cases in which power conversion equipment is used to provide power which is controlled so that it is "better" than the power available . . . (*From* 20-*page booklet, "Static Power Conversion Guide," Hamilton Standard, Div. United Aircraft Corp., Broad Brook, Conn.*)

FOR THIS LITERATURE CIRCLE 355 ON INQUIRY CARD

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Up to 1500 Amperes

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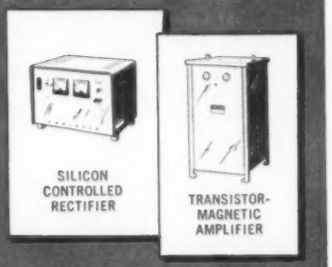

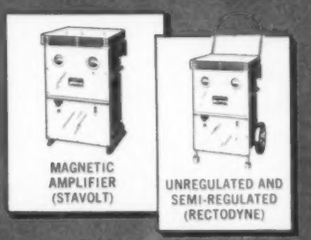

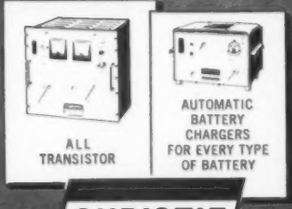

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STATIC
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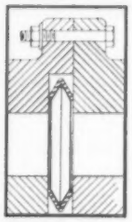

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MODEL	20-1	20-2	20-3	20-4
Stroke (in.)	±.006	±.007	±.008	±.015
Output Radius (in.)	.650	.593	.750	.906
Midposition Force (lb.)	2.5	5.0	8.0	13.0
Hysteresis (%)	2	2	2	2
Resonant Frequency (CPS)	940	790	580	400
Max. Power Req'd (Watts)	1.6	2.65	3.1	5.2
Weight (oz.)	2.8	5.8	9.0	19.5

Servotronics, inc.
190 GRUNER RD. / BUFFALO 25, N.Y. / TX 6-6105

CIRCLE 59 ON READER-SERVICE CARD

New Computer Simplifies Programming

The new Burroughs B5000 solid-state electronic digital computer is said to be the first computer designed especially for "automatic programming." The new system is also said to require no re-programming when the system is expanded or changed. Any size program can be accommodated by any B5000 system, with the larger systems performing the operations in shorter time (Fig. 1).

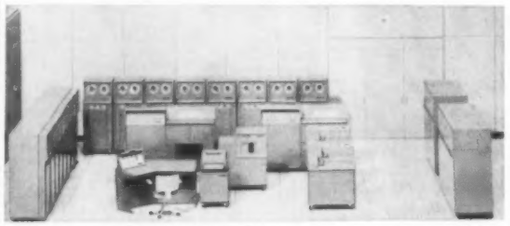


FIG. 1. SOLID-STATE Electronics gives new B5000 digital computer large capacity in small space.

mathematical problem:	*data processing problem:*
d=a(b+c)	FICA DEDUCTION = FICA RATE (GROSS PAY+RAISE)
ALGOL statement:	*COBOL statement:*
D := A x (B+C);	COMPUTE FICA-DED EQUALS FICA-RATE TIMES (GROSS-PAY PLUS RAISE)

FIG. 2. SAMPLE problems in mathematics and data processing are easily programmed using ALGOL and COBOL statements which follow familiar mathematical or business procedures.

The B5000 computer has been designed and developed by the Burroughs Corporation, Detroit, Mich., to accept ALGOL (Algorithmic Language) and COBOL (Common Business Oriented Language) statements (Fig. 2) which can be readily learned by those scientific or experienced business personnel using the computer. These statements, when entered into the computer, are *compiled* into the machine language of the computer. Both the initial programming and subsequent symbolic debugging is thus done in the language of the problem rather than in complex numerical codes requiring a specially-trained coder. Compiling is said to be accomplished from 20 to 50 times faster than the most advanced automatic programming techniques employed to date on conventional computers.

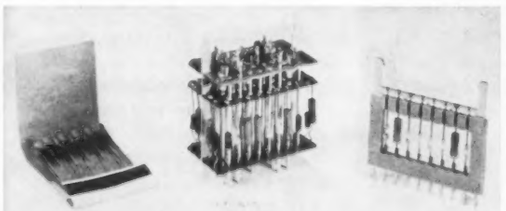
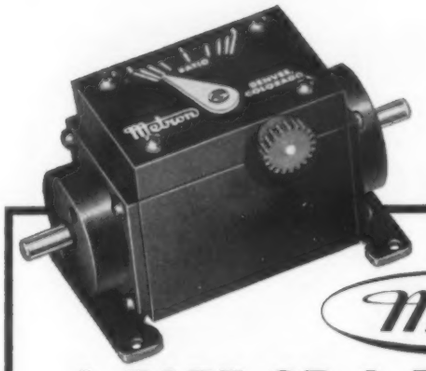


FIG. 3. MODULAR CIRCUITRY was designed by computer procedures for maximum interchangeability and easy maintainability.



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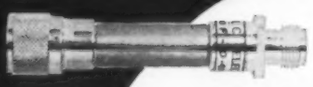

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Pass Band Insertion Loss	0.5 db Max.	0.5 db Max. (1.0 to 1.8 fc)
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Power Rating - 25 Watts — Impedance - 50 ohms
Connectors - BNC, TNC

Cutoff Frequency (Mcs)	Model F-10 Low Pass Length	Model F-20 High Pass Length
100	7 in.	3¼ in.
200	4½	3
300	3⅜	3
400	3	2⅛
600	2⅜	2⅛
800	2½	2⅛
1000	2¼	2⅛
2000	2¼	
4000	2¼	

For Additional information write to Dept. M.

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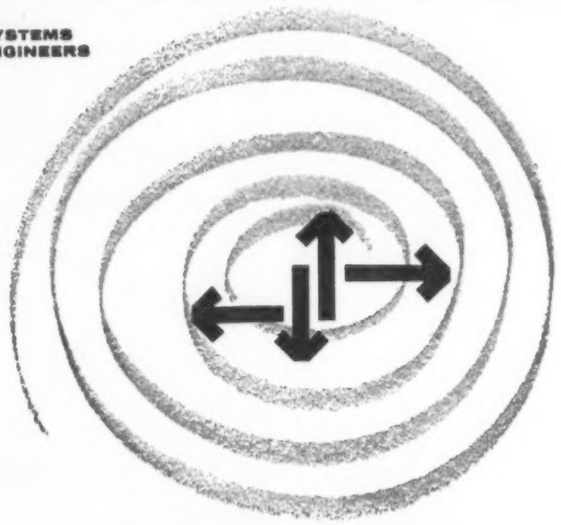
CIRCLE 61 ON READER-SERVICE CARD

SYSTEMS ENGINEERS



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The growing systems engineering activity at the Ordnance Department requires technical generalists in the true sense of the word... men who can begin with an unstructured idea and by applying sound and perceptive understanding of many technical areas, develop the concept of a feasible new system. They must have the ability to understand the operational capabilities and limitations of the entire complex of equipments and subsystems from which they will evolve a particular system. State-of-the-art advances must be monitored continually and examined with a view to deciding how their inclusion within a system matrix will affect its final operational parameters, as well as its cost and time. To verify their decisions, these systems engineers often construct and operate various mathematical models and simulation vehicles. The final recommendation of what system to build and how best to build it is the principal product of systems engineers at Ordnance. However, their responsibilities end only with final test, evaluation and acceptance of the on-line system.

Expanding its work in such vital systems areas as missile guidance and fire control, antennas, directors and underseas weapons, the Ordnance Department in Pittsfield, Massachusetts, has a number of openings for technically versatile engineers.

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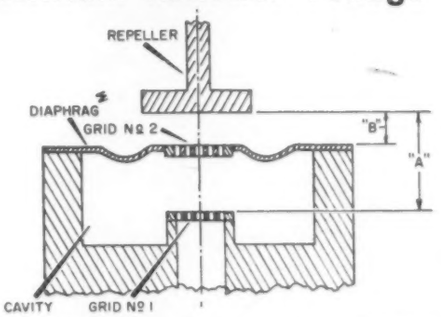
Multi-processing—the simultaneous running of two or more independent programs—is made practical by the computer's high speed (adds in 3 μsec) and flexibility. It also has the ability to operate in fixed-point or floating point representation interchangeably, and in word-length or individual character logic modes. Operations such as card-to-tape, tape-to- printer, etc., which formerly was practical to run only "off-line," can now be performed "on-line" without interrupting other processing.

Modular construction of the solid state electronics for the B5000 (Fig. 3) is interesting not only because of the high component density achieved and the small number of different types of modules required for efficient maintainability, but also because these units are made on a special machine which is directed by punched cards turned out on another Burroughs computer, the B220. The B5000 is, literally, a "new generation" computer.

FOR MORE INFORMATION CIRCLE 137 ON READER-SERVICE CARD

Reflex Klystron Oscillates On Constant Reflector Voltage



The principle upon which the new (SRU-266 Reflex Tube) development is based is quite straightforward. In any reflex tube, the electrons which enter the repeller space must return to the gap in N plus $\frac{3}{4}$ cycles . . . The values of N identify the repeller mode, and operation on the desired mode is obtained by adjusting the repeller voltage. Lower mode numbers are associated with higher (more negative) repeller voltage, since the electrons must be returned more quickly . . . When the tuning system changes the repeller-to-cavity spacing, somewhat different behavior is possible . . . The cavity is tuned by varying the spacing between the two grids, greater spacing being required for higher frequency. If the repeller is held fixed with regard to grid No. 2 (holding dimension "B" constant) the effective repeller to cavity spacing actually increases slightly and the cavity is tuned to higher frequencies, and a larger change in repeller voltage is required to stay near the top of a given mode . . . If, however, the repeller is held fixed with respect to grid No. 1 (holding dimension "A" constant) the repeller to cavity spacing decreases as the cavity is tuned to higher frequencies, and the amount of repeller voltage change required is decreased . . . (*From data sheet, Sperry Electronic Tube Div., Sperry Rand Corp., Gainesville, Fla.*)

FOR THIS LITERATURE CIRCLE 138 ON READER-SERVICE CARD

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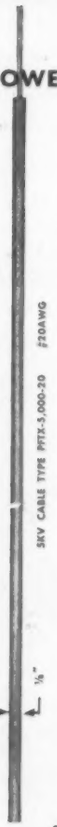
HIGH VOLTAGE CORONA BARRIER BROKEN

IN SMALL DIAMETER, FLEXIBLE HIGH VOLTAGE CABLES

"POWER LINE PERFORMANCE IN HOOK-UP WIRE SIZE"



Now a patented process of laminating Teflon tape with a high dielectric oil reduces the incidence of corona by excluding air from the dielectric and protects the Teflon from damaging effects should corona occur. The graph below illustrates the long life of Teflon film in oil vs. that in air.

Corona is the result when a void (between the conductor and the insulating material or within the insulation) is subject to an ionizing potential. Extruded Teflon is susceptible to separation from the conductor when flexed because of its rigidity and solid mass. Solid Teflon by the very nature of its fabrication contains minute voids within its cross-section. These voids and separations are corona forming points, and without protection the Teflon is subject to deterioration, which degrades the cable.

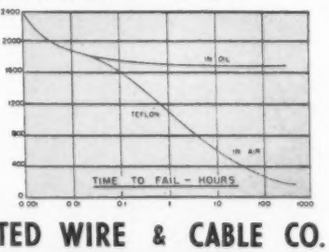
BIW uses thin Teflon tapes, so that any void within the tape is extremely limited in size. In addition, the tape is surrounded with a viscous high temperature — high dielectric oil which fills these voids. Through these techniques, BIW offers a flexible cable with the highest corona threshold in the smallest size.

Braided or extruded jackets are available. FEP 100X extruded Teflon jackets are resistant to acids, alkalies, solvents, abrasion, ozone, ultra-violet, water absorption, oils, fluids, temperatures to 200°C and will not flow at temperatures up to 250°C. With this type jacket, the cable strips easily. It has no braids to leak at high voltage or fray when cut and prevents unravelling of taped dielectric.

BIW laminated Teflon tape and oil constructions demonstrate great reliability over a wide temperature range and are light in weight. Solid colors are available for color coding. These cables are particularly suited to high voltage, high altitude applications where corona is more prevalent. They are ideal for use in shielded cables where small diameter, high voltage leads must run next to ground. Other uses include power plant ignition, high temperature transformers, ignition wires for continuously operating internal combustion engines and chemical processing apparatus. They find wide application in missiles and rockets, electronic equipment, as well as for high temperature, high voltage generator leads and tube cap leads.

Send for the complete brochure — BIW Type HP (High Performance Cable). Your BIW representative will be happy to discuss this and any other wire and cable constructions with you.

Teflon is a product of DuPont



THIS GRAPH shows voltage-life tests of Teflon film 0.005" in thickness. Note the comparative long life of Teflon protected with oil. BIW process for manufacturing Teflon insulated cables protects with dielectric oil.

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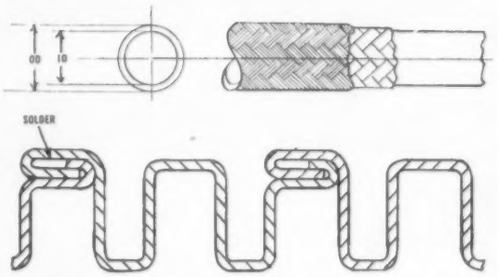
CIRCLE 65 ON READER-SERVICE CARD

Flexible Shielding Conduit



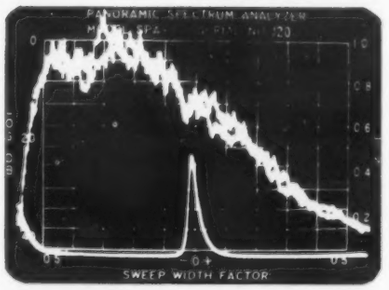
MS TYPE TUBING (brass) and two layers of bronze braiding. Lower detail shows section of tubing wall.

Breeze Conduit is flexible metal tubing having interlocking seams and is covered with one or more layers of woven wire braid. In some cases, a synthetic rubber or plastic covering is added also . . . Complete assemblies can be provided, consisting of conduit and ferrule end fittings fastened to the conduit by swaging or soldering or both . . .

Some types are designed to provide fire protection, others abrasion resistance, light weight, extra flexibility or resistance to corrosion. Some are waterproof. They are designed to meet military requirements and have proved their value as well in industrial, aircraft, automotive and marine applications . . . (*From 36-page Catalog 55CF, Breeze Corps., Inc., 700 Liberty Ave., Union, N. J.*)

FOR THIS LITERATURE CIRCLE 139 ON READER-SERVICE CARD

Panoramic Spectrum Analyzer



The Models SPA-3 and SPA-3/25 are automatically sweeping spectrum analyzers which cover the spectrum from 200 cps to 15 mc and 25 mc, respectively. They are designed to display any selectable segment in this range up to 3 mc wide. A calibrated dial permits sweep width variation from 3 mc down to 0 mc. A calibrated center frequency control in the SPA-3 enables centering of any frequency between 0 and 13.5 mc on the screen. The centering range in the SPA-3/25 is between 0 and 23.5 mc. Noise spectrum and marker. Spa-3 video filter smooths noise envelope (as shown) . . . . (*From 4-page bulletin and 12-page Catalog, Panoramic Radio Products, Inc., 520 S. Fulton Ave., Mount Vernon, N. Y.*

FOR THIS LITERATURE CIRCLE 140 ON READER-SERVICE CARD

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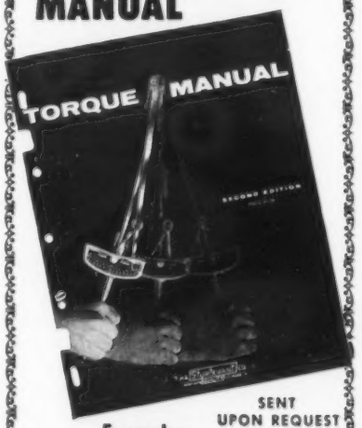
"TORQUE WRENCH" MANUAL



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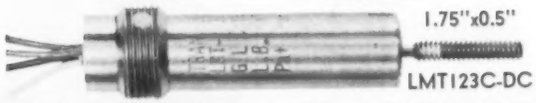
NEW

DIRECT CURRENT

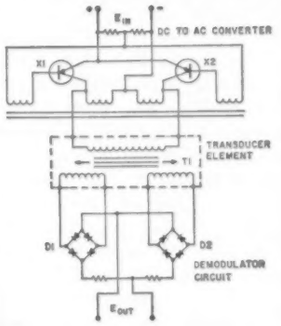


DISPLACEMENT TRANSDUCER

SPECIFICATIONS

Type:	LVDT
Scale Factor:	120 V/in DC
Stroke:	±0.10 in.
Linearity:	0.5% full scale
Static Resolution:	∞
Dynamic Response:	> 500 CPS
Temp. Range:	−65° F to +250° F
Excitation:	24VDC

Construction: Magnetically shielded; pressurized for direct insertion into hydraulic fluid; threaded case with nylon lock; threaded probe shaft.



G. L. COLLINS CORPORATION
2820 EAST HULLETT ST. LONG BEACH 5, CALIF.
METCALF 0-3121—TWX: CPT-6009

CIRCLE 68 ON READER-SERVICE CARD

TERMINAL BOARDS

Kulka Military Terminal Boards were designed by the Bureau of Ships according to MIL-T-16784B. They are made to BUSHIPS 9000-S6505-73214 drawings, with latest revisions, and BUORD S64101.

Kulka Military Boards are available as single row, double row, or through connected type units, and are molded of Type MAI-60 glass-filled alkyd resin according to the latest revision of M-14 specifications.

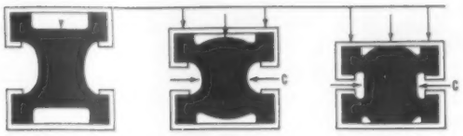
Kulka offers the complete line of these Military Boards, along with a wide selection of hardware accessories...

The complete catalog on Military Terminal Boards.... Write for your FREE copy...

KULKA ELECTRIC CORP.
633-643 SO. FULTON AVENUE, MOUNT VERNON, N. Y.

CIRCLE 69 ON READER-SERVICE CARD

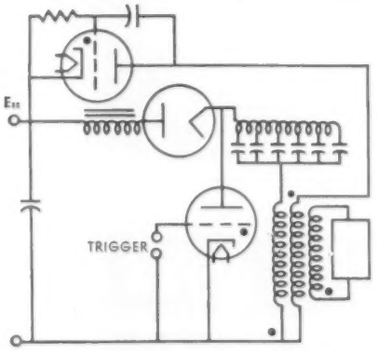
Vibration Mounts



Rexon mounts utilize the time-proven vibration dampening properties of rubber-in-shear, but with no possibility of overloading the shear elements. This unique property stems from the use of a special "X" design of the rubber element which acts in shear at the points of the "X" under normal loading, but in compression when the load exceeds the rated capacity of the mount. Each Rexon mount consists of one, two, or more "X" rubber elements inserted in steel retaining channels encased in a protective metal cover . . . (*From 8-page brochure, Rexon Mount Div., Hamilton Kent Mfg. Co., 427 W. Grant St., Kent, Ohio.*)

FOR THIS LITERATURE CIRCLE 141 ON READER-SERVICE CARD

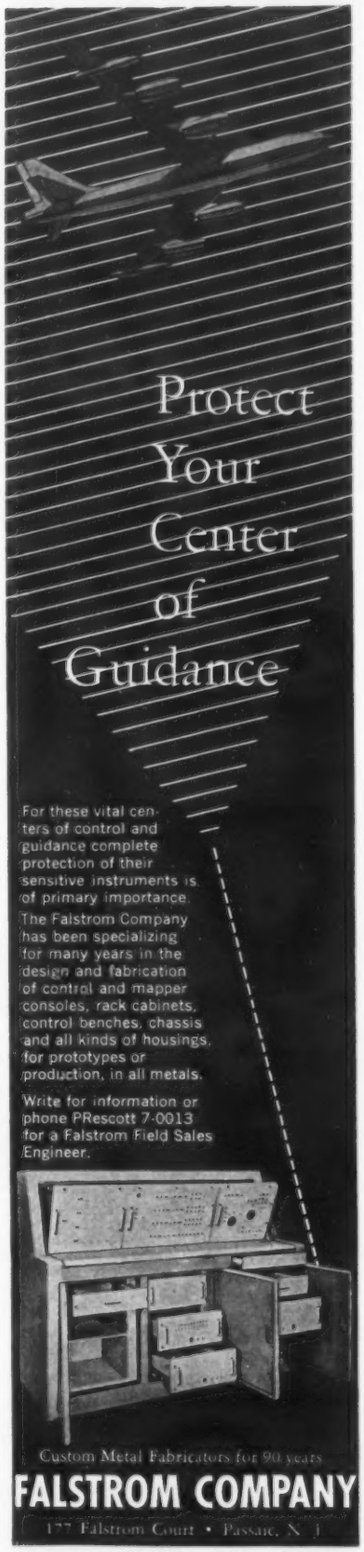
Applications of the Hydrogen Thyratron



Many loads do not act as constant resistances . . . Many RF impedances vary over a wide range during pulsing. In other cases, the mismatch between pulse-forming network impedance and load cannot be kept within the limits required by tube rating sheets. Several methods are available to compensate for these effects, so that the hydrogen thyratron switch tube can function . . .

When it is necessary to limit the maximum voltage which can appear across the load, a clamper circuit can be used . . . By careful transformer design, the voltage at the anode of the clamper tube can be made to be greater than the d-c supply voltage when load voltage becomes greater than a predetermined permissible value. The self-triggering clamper tube will then conduct current until its anode voltage approaches supply voltage. Energy originally intended for dissipation in the load is thus returned to the power supply. Excessive forward voltages are avoided in this way . . . (*From 20-page Bulletin PT-49, Power Tube Dept., General Electric, Schenectady 5, N. Y.*)

FOR THIS LITERATURE CIRCLE 142 ON READER-SERVICE CARD


Protect Your Center of Guidance
For these vital centers of control and guidance complete protection of their sensitive instruments is of primary importance.
The Falstrom Company has been specializing for many years in the design and fabrication of control and mapper consoles, rack cabinets, control benches, chassis and all kinds of housings, for prototypes or production, in all metals.
Write for information or phone PRescott 7-0013 for a Falstrom Field Sales Engineer.
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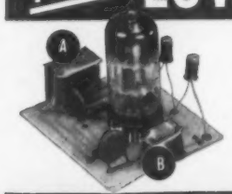
CIRCLE 70 ON READER-SERVICE CARD

MINIATURIZATION PLUS LOWER COST



Thin Versatile Co-Netic and Netic Magnetic Shielding Foils

Permit positioning foil-wrapped components A & B closely, minimizing interaction due to magnetic fields . . . making possible compact and less costly systems.

How thin Co-Netic and Netic foils lower your magnetic shielding costs:

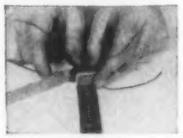
1) Weight reduction. Less shielding material is used because foils (a) are only .004″ thick and (b) cut and contour easily.

2) Odd shaped and hard-to-get-at components are readily shielded, saving valuable time, minimizing tooling costs.

These foils are non-shock sensitive, non-retentive, require no periodic annealing. When grounded, they effectively shield electrostatic and magnetic fields over a wide range of intensities. Both foils available from stock in any desired length in various widths.

Co-Netic and Netic foils are successfully solving many types of electronic circuitry magnetic shielding problems for commercial, military and laboratory applications. These foils can be your short cut in solving magnetic problems.

Cuts readily to any shape with ordinary scissors.


Wraps easily.

Inserts readily to convert existing non-shielding enclosures.

Shielding cables reduces magnetic radiation or pickup.

Wrapping tubes prevents outside magnetic interference.

PROTECT VITAL MAGNETIC TAPES

When accidentally exposed to unpredictable magnetic fields, presto!—your valuable data is combined with confusing signals or even erased.

For complete, distortion-free protection of valuable magnetic tapes during transportation or storage. Single or multiple reel Rigid Netic Enclosures available in many convenient sizes and shapes.

Thin pliable foil wraps easily around magnetic tape, maintaining original recorded fidelity.

Rigid Netic (.014″ and up in thickness) Shielded Rooms and Enclosures for safe, distortion-free storage of large quantities of recorded magnetic tapes.

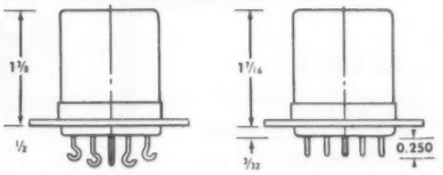
Composite photo to demonstrating that magnetic shielding qualities of Rigid Netic Alloy Material are not significantly affected by vibration, shock (including dropping or bumping) etc. Netic is non-retentive, requires no periodic annealing.

Write for further details today.

MAGNETIC SHIELD DIVISION PERFECTION MICA CO.
1322 No. Elston Avenue, Chicago 22, Illinois
ORIGINATORS OF PERMANENTLY EFFECTIVE NETIC CO-NETIC MAGNETIC SHIELDING

CIRCLE 71 ON READER-SERVICE CARD

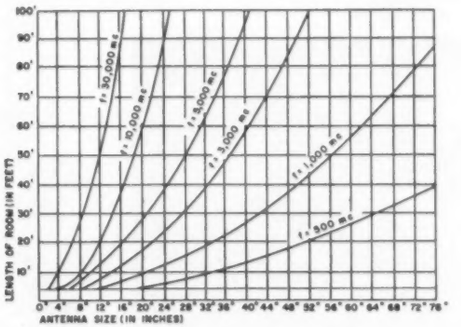
Wedge-Action Relay



The Mark 11 relay, with patented wedge action, makes a major contribution to optimum relay performance . . . One end of the pole, or moving contact, is anchored in the relay header. The other end is firmly joined to the actuator mechanism. In the de-energized position, the pole is held firmly against the top contact by the return spring. When the coil is energized, the magnetic field depresses the plunger and actuator mechanism, disengaging the normally-closed (upper) contact, then engaging the pole with the normally-open (bottom) contact. Because the movable contact face is angled, a positive wiping action is developed during both make and break movements. In addition, contact pressure increases during overtravel . . . (*From 6-page Bulletin 20P, Electro-Tec Corp., 10 Romanelli Ave., South Hackensack, N. J.*)

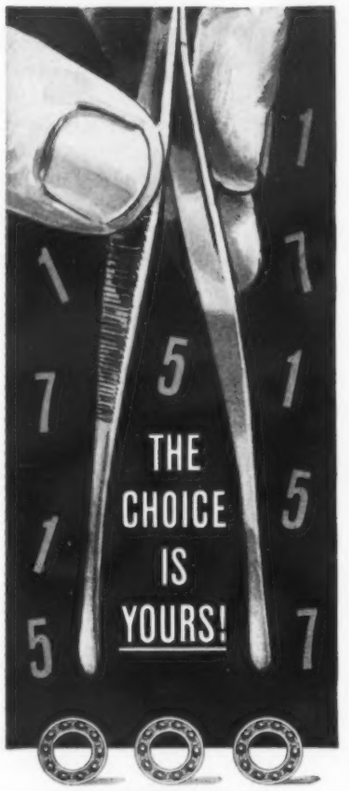
FOR THIS LITERATURE CIRCLE 143 ON READER-SERVICE CARD

Free Space Room Design



The "free space room" is an enclosure of sufficient size and lined with material which will absorb the antenna radiation not directed at the receiver . . . Each individual free space room design is the result of careful consideration of the many variables involved: frequency ranges, types of measurements, optimum shape and size of room, quality and type of absorber to be used, types of antennas to be tested, and desired test standards . . . Room size . . . is of crucial importance in room design. Depending on frequency, antennas to be tested, and types of tests, a room might be anywhere from 8′ to 100′ long. To assist you in determining your space needs, we have evolved the following tables which will give you a rough idea of the overall dimensions of the room you need . . . (*From 18-page report, McMillan Electronics Div., Brownville Ave., Ipswich, Mass.*)

FOR THIS LITERATURE CIRCLE 144 ON READER-SERVICE CARD



RMB

RMB miniature and instrument ball bearings are available in ABEC-1, ABEC-5 and ABEC-7 tolerances.

ONLY ONE OF THESE IS BEST FOR YOUR APPLICATION

For highly sensitive and high speed applications you'll choose the RMB ABEC-5 or -7 bearing.

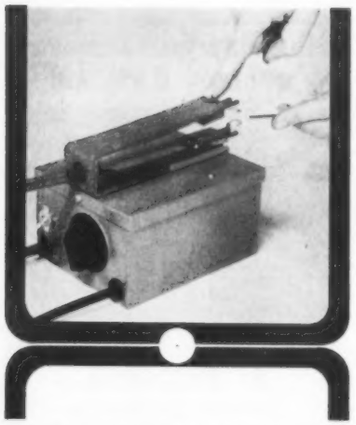
For applications of less exacting requirements, you'll want to take advantage of the reduced cost of the RMB ABEC-1 bearing.

IT'S YOUR APPLICATION—YOU MAKE THE CHOICE

Find out more about the RMB line... Ask for Catalog 4E-1.

LANDIS & GYR, inc.
45 West 45th St.
New York 36, N. Y.

CIRCLE 72 ON READER-SERVICE CARD



MODEL G THERMAL WIRE STRIPPER

Strips both Teflon and low-melting plastics.
No blades to cut or nick wire.
Has continuously-variable heat control.
Strips any size wire without adjustment.
Use either as bench or hand tool.
Designed for production-line use.
Price $69.50 FOB Altadena, Calif.
Always available from stock.

Western Electronic Products Co.
2420 North Lake Avenue, Altadena, Calif.

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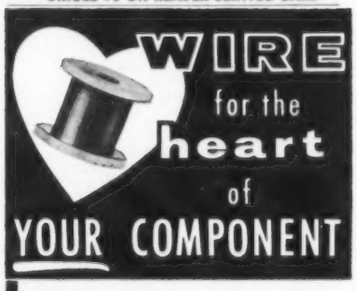

Wire drawn to your specifications (down to .00025") in base and precious metals and alloys . . . supplied bare, enameled, ceramic insulated for use at 1000° F., or electroplated . . . to close tolerances.

Our research and development staff is available to solve YOUR wire problems.

Write for data on your specific needs.

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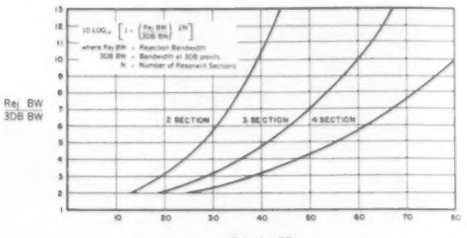
7 Intervale St., White Plains, N.Y.
White Plains 9-4757

CIRCLE 74 ON READER-SERVICE CARD

Tunable Band-Pass Filters

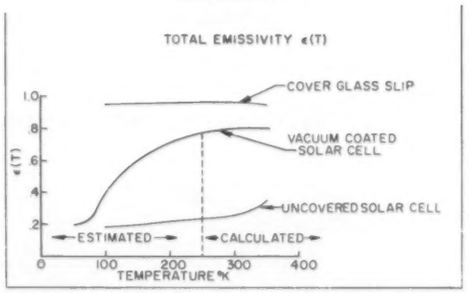


Pass-Band and rejection characteristics . . . of calibrated microwave tunable band-pass filters . . . are calculated from the equation (shown).

The curves are offered as a guide for selecting rejection characteristics vs. number of sections . . . (*From 6-page Data Sheet F-1, John Gombos Co., Inc., Webro Rd., Clifton, N. J.*)

FOR THIS LITERATURE CIRCLE 148 ON READER-SERVICE CARD

Emissivity Enhancement of Solar Cells for Temperature Control



EMISSIVITY Enhancement Control is important factor in design of solar power packs for space vehicles.

Silicon solar cells are often used as an electrical power source for satellites and other space vehicles. The solar cells are fitted to a large portion of the external surface of the satellite, and absorb most of the sun's energy which falls upon them. Approximately 10% to 15% of this energy is effective in producing electrical power while the remaining energy heats the solar cells and often the satellite itself. The heat not only reduces the efficiency of the solar cells in converting sunlight into electrical power, but may impair the operation of the satellite's instrumentation. In the vacuum environment encountered in outer space, the only effective means of "cooling" the solar power pack is by reradiating the energy absorbed from the sun back into space.

The need for emissivity enhancement in the infrared is derived from the fact that the solar cells have a low emissivity in the long wave length range.

Several methods are currently available for increasing the infrared emissivity of the cells and thereby reducing the equilibrum temperature. (*From 11-page Technical Report No. 1, Military Products Division, Bausch & Lomb Incorporated, Rochester 2, N. Y.*)

FOR THIS LITERATURE CIRCLE 149 ON READER-SERVICE CARD

first from **triolab** ...
a new standard of precision in AC VTVMS

now measure both complex and sine waves with 0.25% accuracy

'Til now, no VTVM has been able to measure complex waves with high laboratory standard accuracy. Average-reading and peak-reading instruments are subject to significant distortions created by spikes and harmonics.

New **triolab** Model 120 achieves direct-reading, true RMS values of both sine and complex waves with deflection directly proportional to the square of the current—by use of a special dynamometer movement.

- **DIRECT-READING**
  No knobs to twist or tedious balancing.
- **INSTANT MEASUREMENT**
  No sluggish, thermo-couple response.
- **HIGHEST LEGIBILITY**
  Full 7" custom-calibrated, mirror scale.
- **CONSTANT OVERALL GAIN**
  For long life.
- **DIAMOND BEARINGS**
  For perfect balance, smooth scale motion.

Ranges: 10MV to 500V rms, full scale. Input impedance: 1 meg. Fundamental freq. response: 50-2000 cps. Accuracy (above 50% electrical deflection): ¼% f.s. at 400 cps; ½% f.s. at all other frequencies. Power: 115 VAC, 50-400 cps.

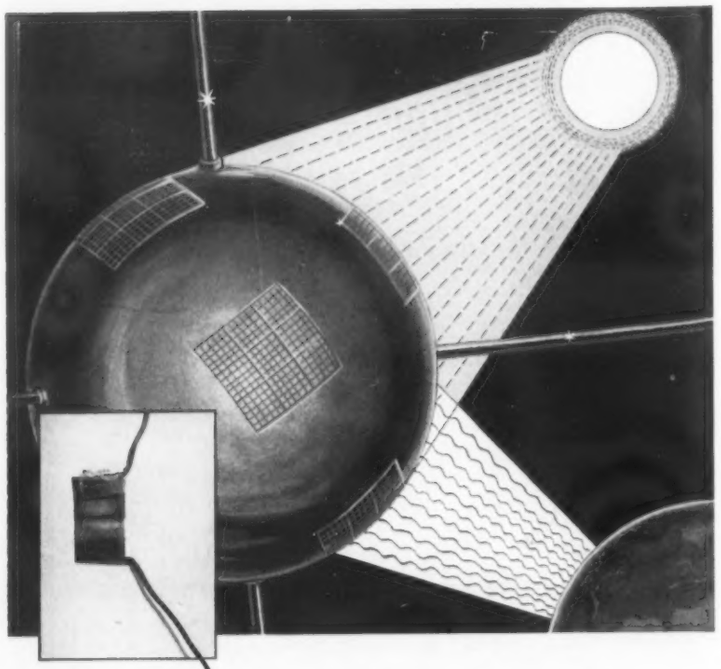
AVAILABLE RACK-MOUNTED OR PORTABLE

triolab other laboratory and **build-in** miniature precision instruments can help you. Write for Catalog MSD-4

triolab

TRIO LABORATORIES, INC., Plainview, L. I., N. Y.
Export Dept: EMEC, 127 Grace St., Plainview, N.Y.

CIRCLE 75 ON READER-SERVICE CARD



Taming the sun's energy to solar battery needs

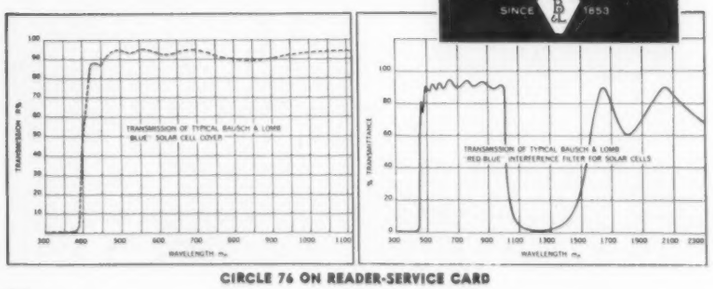
Bausch & Lomb optical/electronic/mechanical capabilities increase cell efficiency

The only trouble with solar energy for satellite power supply is that there's too much of it. Only about 10% of the sun's radiation can be transformed into electrical energy. The remaining 90% just heats the solar cells, reducing their efficiency.

Bausch & Lomb coatings enhance the efficiency of solar cells by allowing them to operate at cooler temperatures. "Blue" (see typical curve) coatings—selectively absorb the radiation needed to energize the cells. The "Red-blue" coatings bounce the hot infra-red radiation back into space (see typical "red-blue" curve).

Find out how B&L capabilities can help out on *your* next project—in design, development and production. Ask for our technical reports: Bausch & Lomb Incorporated, Military Products Division 92116 Bausch Street, Rochester 2, N. Y.

BAUSCH & LOMB
SINCE 1853


TRANSMISSION OF TYPICAL BAUSCH & LOMB BLUE SOLAR CELL COVER
TRANSMISSION OF TYPICAL BAUSCH & LOMB RED-BLUE INTERFERENCE FILTER FOR SOLAR CELLS

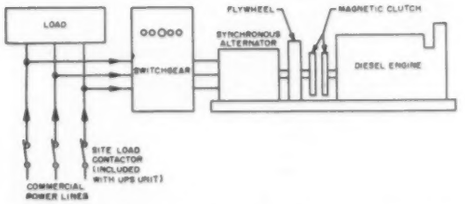
CIRCLE 76 ON READER-SERVICE CARD

Heater-Freezer

A device, smaller than a paper clip, . . . can freeze or boil a drop of water on power from two flashlight batteries . . . In clusters, its uses vary from maintaining room temperature in a space ship to operating an instant-defrosting refrigerator with no moving parts . . . A thermoelectric device—also known as a Peltier cooler—produces heat at the junction of two special semiconductor materials when a current is passed through it . . . It cools when the direction of current flow is reversed. As a result, the same element can be used for both cooling and heating by connecting a simple switch in the circuit to control the direction of current . . . (*From news release, Hughes Aircraft Co., Florence Ave., & Teale St., Culver City, Calif.*)

FOR MORE INFORMATION CIRCLE 150 ON READER-SERVICE CARD

Power Without Interruption

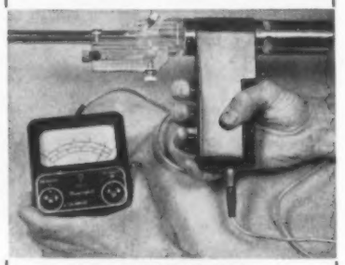


The Uninterrupted Power Supply consists of a synchronous alternator and flywheel connected to a diesel engine through a magnetic clutch. The synchronous alternator normally operates on commercial power and rotates the flywheel. Power is fed to the load and to the unit through the site load contactor.

If power fails or falls below established minimums, a reverse power relay opens the site load contactor and energizes the magnetic clutch. Inertia in the rotating flywheel starts the diesel engine and also carries the load on the alternator during the transition period. The diesel engine then assumes the load and the UPS continues to produce power. During diesel operations commercial power is constantly checked for quality. Once normal commercial power is again available, UPS automatically varies the speed of the diesel engine to synchronize its output with the commercial power. When synchronization is achieved, the load is shifted back to the commercial line, and UPS returns to its standby condition (shown) . . . (*From 8-page Bulletin P-2, Power Equipment Div., Consolidated Diesel Electric Corp., Stamford, Conn.*)

FOR THIS LITERATURE CIRCLE 151 ON READER-SERVICE CARD

Humidity measurements within ± 0.5% RH!



A+ HYGROPHIL
thermistor psychrometer

- Measures temperatures from 10°F to 176°F
- Response time: 10 to 20 seconds for final reading
- Reproducible readings every time. Readability ¼°
- Indicates wet and dry bulb thermistor (resistance temperature detector) readings of air temperatures.

$290 complete with case
Specify F° or C° scale
Write for Bulletin

Atkins Technical Inc.
1276 W. Third Street
Cleveland 13, Ohio
Phone: SU 1-1332
temperature and humidity instrumentation

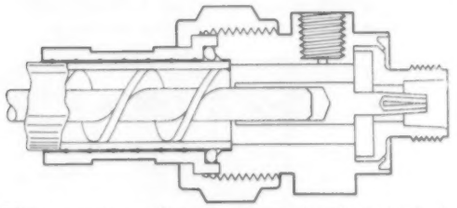
CIRCLE 77 ON READER-SERVICE CARD

Special Editorial Emphasis on

Infrared and Solar Cell Devices

will highlight the June issue of MILITARY SYSTEMS DESIGN. Ad closing date—June 1. Future issues will treat Resistive Components (August); Reactive Components (October); Gyros and Stable Platforms (December). FOR ADVERTISING **RESULTS** —advertise in **every** issue. Contact any MSD Rep—see inside front cover for addresses.

Connectors for Coaxial Cables

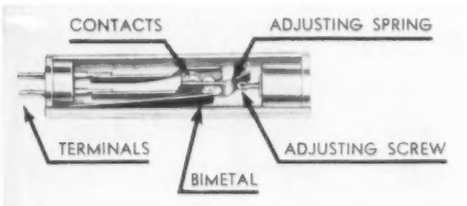


New connectors for aluminum sheathed, high frequency Styroflex and Foamflex Coaxial Cables feature no radiation, low attenuation, excellent frequency response . . . Cables feature low standing wave ratio . . . (*From 8-page brochure, Phelps Dodge Copper Products Corp., 300 Park Ave., New York 22, N. Y.*)

FOR THIS LITERATURE CIRCLE 156 ON READER-SERVICE CARD

Miniature Thermostat Drifts Less Than 1° in 500,000 Operations

The use of ordinary thermostats in electronic components and apparatus has long been a problem to electronic engineers. Their relatively large size and awkward shape has annoyed the designer faced with space problems. The habitual changing of operating temperature after a short operating life has caused crystal ovens and oscillator compartments to become



useless after a few months time. New Model 292 Thermostat is hermetically sealed so that it will hold its control temperature to 1½°C for over 500,000 operations with a resistive load of ½ ampere at 26-v dc. It can handle loads up to ½ ampere at 115-v 60 cycles ac.

Factory set to a tolerance of ± 1°C, it can control small ovens with variations of less than ±½°C over a wide range of ambient temperatures.

This (tiny 0.317" dia. x 1.325") control is constructed in such a way that the current carried passes only through contact springs of high electrical conductivity and not by the bimetal. The contact materials also permit superior operation at very low voltages and in dry circuit applications.

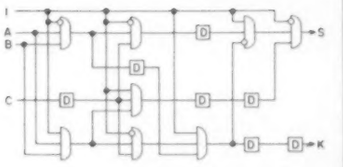
Because of its small size and low mass, the thermostat is extremely vibration and shock resistant. Since the operating structure is independent of the outer shell, damage to the shell can have no effect on the temperature setting.—*Instruments Div., Thomas A. Edison Industries, McGraw-Edison Co., 61 Alden St., West Orange, N. J.*

FOR THIS LITERATURE CIRCLE 157 ON READER-SERVICE CARD

The binary adder stage produced in conventional design (top) has been reduced and simplified through Majority Logic Design to the diagram and formula at the bottom. Discovered and formulated in the Remington Rand Univac Mathematics and Logic Research Department, Majority Decision Logic is a new logical algebra, which opens new and interesting possibilities for the reduction in the number of logical elements in computer design.

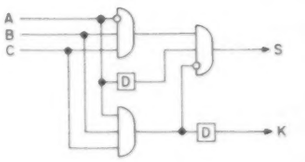
$K=(A+B)\cdot C+A\cdot B$

$S=(A\cdot B\cdot C+\overline{K})\cdot(A+B+C)$



$K=A\oplus B\oplus C$

$S=(\overline{A}\oplus B\oplus C)\oplus A\oplus\overline{K}$



Univac now has a number of opportunities for participation in exceptionally interesting projects which offer both professional and personal reward. These positions are significant in their potential for advancement.

The following are among those openings immediately available to experienced, capable people:

- COMPUTER APPLICATIONS ANALYSTS
- MILITARY SYSTEMS ANALYSTS
- INFORMATION STORAGE AND RETRIEVAL SPECIALISTS
- COMPUTER PROGRAMMERS
- COMPUTER LOGICAL DESIGNERS
- OPERATIONS RESEARCH ANALYSTS

Send resume of experience and education to: R. K. PATTERSON, **Dept. FF-3**

Remington Rand Univac

Division of Sperry Rand Corporation • Univac Park • St. Paul 16, Minnesota

Easy to clean pressure cavity, during ground testing, is reached by simply removing 12 screws.

TABER TELEFLIGHT® goes with the "BIRD"

The PRESSURE TRANSDUCER that dissipates HEAT to its CASE to defeat zero gravity heat build-up

There is a whole family of Teledyne and Teleflight Pressure Transducers available for airborne or ground support application. Naturally, our star in the missile and rocket field is our tiny 9½ oz. Teleflight at the left. This Teleflight precisely measures liquid or gas pressures at 0.25% over a wide 0 to 2,000 PSIG or PSIA temperature range. Bonded strain gage construction assures low sensitivity to shock and vibration. When the Teleflight is subjected to zero gravity conditions (as in space flight where convection cooling is non-existent) the Ni-Span proving ring acts as a heat sink and conducts heat AWAY from the resistance gages to the instrument case. Handles corrosive media including fuming NITRIC ACID. With slight factory modifications, can also handle Fluorine. 200% overload protection built in at no extra cost. Infinite resolution, Linearity 0.25%, Hysteresis 0.25%, Temperature —150° to +275° F., Repeatability within 0.1%. Taber also produces a complete line of miniature transistor amplifiers or will build complete Electronic Systems to your specifications.

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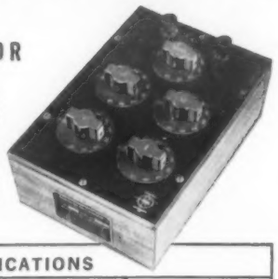
Taber®

CIRCLE 78 ON READER-SERVICE CARD

FOR PRECISION MEASUREMENTS

RESISTANCE DECADES—MODEL DR



Available in a wide variety of standard models. Accuracy at 1.0 and 0.1 ohm steps is ±0.25%. Accuracy of all other resistors is ±0.1% of indicated value. Self-cleaning, molded nylon and silver plated brass switch mounted below panel. Zero resistance is less than .003 ohms per dial. Hardwood case. Models DR-1D to DR-4D, 8" x 5½" x 4½" h. Weight 4 lbs. net, 6 lbs. shipping. Models DR-50D to DR-52D, 9" x 6" x 4½" h. Weight 5 lbs. net, 7 lbs. shipping. Models DR-70D and DR-71D, 17¼" x 5" x 4½" h. Weight 6 lbs. net, 8 lbs. shipping.

ELECTRICAL SPECIFICATIONS

Model No.	Total Res. Ohms	Decade Steps	Accuracy
DR-1D	1,110,000	10x(1,000+10,000+100,000)	±0.1%
DR-2D	111,000	10x(100+1,000+10,000)	±0.1%
DR-3D	11,100	10x(10+100+1,000)	+0.1%
DR-4D	1,100	10x(1.+10+100)	±0.25 & ±0.1%
DR-50D	11,111	10x(.1+1+10+100+1,000)	±0.25 & ±0.1%
DR-51D	111,110	10x(1+10+100+1,000+10,000)	±0.25 & ±0.1%
DR-52D	1,111,100	10x(10+100+1,000+10,000+100,000)	±0.1%
DR-70D	1,111,111	10x(.1+1+10+100+1,000+10,000+100,000)	±0.25 & ±0.1%
DR-71D	11,111,110	10x(1+10+100+1,000+10,000 +100,000+1,000,000)	±0.25 & ±0.1%

WHEATSTONE BRIDGES — MODEL RN

Universally used for the measurement of all types of resistance devices and circuits where high accuracy is required. Models available for performing Murray-Varley Loop tests.

ELECTRICAL SPECIFICATIONS

Model	Total Res. of Decade	Ratio Dial Settings	Circuits	Dimensions
RN-1	9X(1+10+100+1000)	.001, .01, .1, 1.0, 10, 100, 1000	.....	9"x8"x6½"
RN-2	9X(1+10+100+1000)	.001, .01, .1, 1.0, 10, 1000, M10, M100, M1000	Murray & Varley	9x"x8"x6½"
RN-3	10X(1+10+100)+9(1000)	1/1000, 1/100, 1/10, 1/9, 1/4, 1/1, 10/1, 100/1, M10, M100, M1000	Murray & Varley	9½"x8"x8½"

CAPACITANCE DECADES — MODEL DK

These are 3-dial units with the sum of the dial setting indicating total capacity in microfarads. Mylar and silver-mica capacitors are used for high stability, low-loss characteristics. Polished hardwood case, engraved dial graduations.

ELECTRICAL SPECIFICATIONS

Model	Decade Steps (MFD)	Accuracy	Dielectric	Power Factor	Peak Volts
DK-2A	0.001, 0.01, 0.1	±1.%, ±1.%, ±1.%	Silver Mica	0.2%, 0.2%, 0.2%	700, 700, 500
DK-4	0.001, 0.01, 0.1	±1.%, ±1.%, ±3.%	Silver Mica, Mica & Foil, Mylar	0.2%, 0.2%, 1.%	700, 700, 400
DK-5A	0.01, 0.1, 1.0	±1.%, ±3.%, ±3.%	Mica & Foil, Mylar Mylar	0.2%, 1.%, 1.%	700, 400, 400
DK-11A	0.01, 0.1, 1.0	±0.5%, ±0.5%, ±2.0%	Silver Mica, Silver Mica, Mylar	0.2%, 0.2%, 1.0%	700, 500, 400
DK-10	0.0001, 0.001, 0.01	±0.5% or 10 mmf	Silver Mica	2.0%, .2%, .2%	700, 700, 700

PHYSICAL SPECIFICATIONS

	Over-all Dimensions	Weight (Lbs.) Net	Shipping
DK-2A, DK-4, DK-10	8 x 5½ x 7½	8	10
DK-5A, DK-11A	10¾ x 7¾ x 7½	10	12

Industrial Instruments

Industrial Instruments
89 COMMERCE ROAD, CEDAR GROVE, N. J.

CIRCLE 79 ON READER-SERVICE CARD

MSD new products

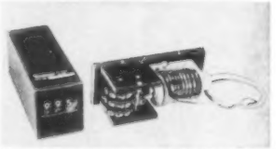
COMPUTER COMPONENTS

AIRBORNE DIGITAL COMPUTER

New lightweight, airborne Digital Computer System for navigation, guidance and control of drone aircraft uses solid-state modules and unique packaging. Computer is general-purpose 2-address, serial, binary-data type, utilizing 12,000-rpm memory drum with 2048-word capacity (21-bits per word).—*Motorola Inc., Western Center, Military Electronics Div., 8201 East McDowell Rd., Scottsdale, Ariz.*

CIRCLE 158 ON READER-SERVICE CARD

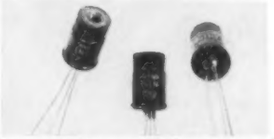
IMPULSE COUNTER



New 1" x 1" x 3" Model 11576 Impulse Counter provides declining readings in 5-unit increments from "995" to "000". Maximum speed of response is 1320 impulses/min; meets mil specs.—*Bowmar Instrument Corp., 8000 Bluffton Rd., Fort Wayne, Ind.*

CIRCLE 159 ON READER-SERVICE CARD

POWER TRANSISTOR

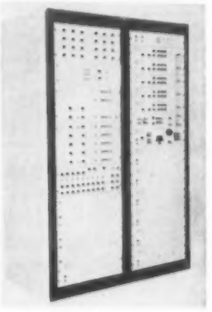


New military PNP Germanium Power Transistor, JAN-2N158 can operate relays, control servo motors, and drive magnetic amplifiers. Maximum ratings at 25°C are: —60 volts collector-to-emitter voltage, 2 amps emitter current. Minimum current gain is 21.—Bulletin E-376.—*CBS Electronics Information Services, 100 Endicott St., Danvers, Mass.*

CIRCLE 160 ON READER-SERVICE CARD

MEMORY CORE TESTER

New Type 2102 Automatic Memory Core Tester generates four different programs of current driving pulses.

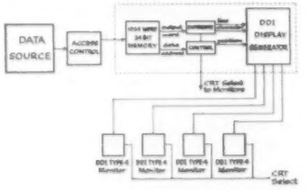


Calibrated sensing system compares core output at five specific times against six known and variable amplitude levels; core amplitudes subjected to up to seven accept-reject decisions, based on predetermined specs; rejected and accepted cores counted during testing.—*Digital Equipment Corp., Maynard, Mass.*

CIRCLE 161 ON READER-SERVICE CARD

DISPLAY SYSTEM

New dd74 general purpose alphanumeric display system has magnetic stored memory with full random ac-



cess, 8-μsec cycle time; capacity 1,024 24-bit words. Displays any symbol in any position in 40 vertical columns and 24 horizontal rows.—*Data Display, Inc., 1820 Como Ave., St. Paul 8, Minn.*

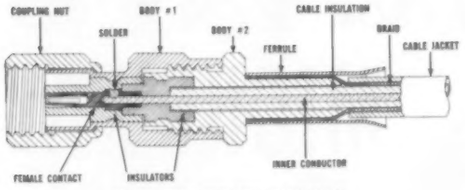
CIRCLE 162 ON READER-SERVICE CARD

DATA SIMULATOR

New Dator Data Simulators generate electrical signals which simulate high precision synchros, resolvers, potentiometers, etc. to test analog systems. Illustrated unit simulates 26-v, 3-wire synchro transmitter at 5° increments from 0°-360°.—*Angler Industries, Metuchen, N. J.*

CIRCLE 163 ON READER-SERVICE CARD

Miniature R. F. Connectors

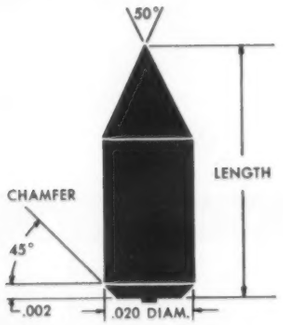


CRIMP TYPE SCREW-ON CABLE PLUG

In addition to the choice of Screw-on or Snap-on mating characteristics, ConheX connectors are available in two basic designs for the clamping of the connector to the associated cable. These are the Cable Clamp type and the Cable Crimp type . . . The ConheX Crimp design is especially suited to the mass production of cable assemblies, . . . will save up to 60% assembly time over conventional designs. A tubular extension of the body slides between the dielectric and the metal braid of the cable, while a ferrule of larger diameter is slipped into place over the cable braid. Regulated pressure through the use of a special crimping tool . . . locks the braid securely between the body extension and the ferrule . . . (*From* 12-*page Catalog D*2-1 *Sealectro Corp.*, 139 *Hoyt St., Mamaroneck, N. Y.*)

FOR THIS LITERATURE CIRCLE 164 ON READER-SERVICE CARD

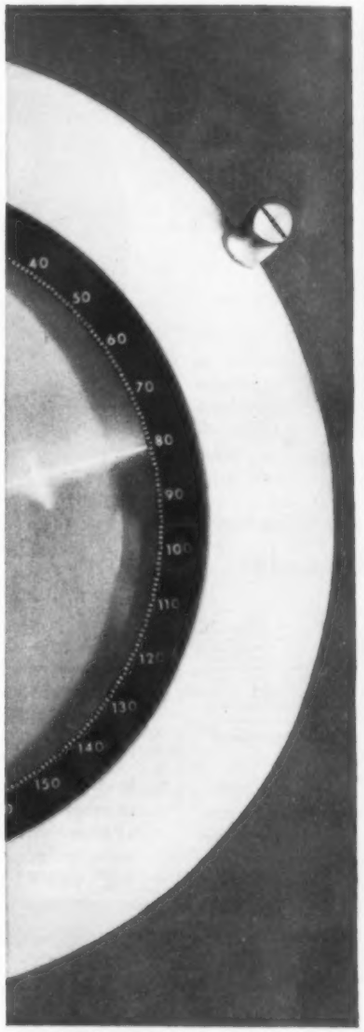
Precision Instrument Pivots



Johnson precision pivots are mass produced to a very fine degree of hardness and polish, observing dimensional tolerances to .0001 inch . . . A pivot angle of 50° has been found to be a good compromise that gives adequate strength to withstand the most severe shock and yet is small enough for delicate sensitive instruments . . . In delicate, low energy instruments, where it is possible for a small degree of magnetism in the pivot to effect the accuracy and sensitivity of the instrument, non-magnetic pivots are recommended . . . The pivot point curvature should be as small as is consistent with satisfactory operation in service. If a pivot is too sharp for an application, shock will tend to flatten the pivot surfaces against the jewel . . . (*From* 4-*page Bulletin* 700, *Welton V. Johnson Engineering Co., Inc.*, 95 *Summit Ave., Summit, N. J.*)

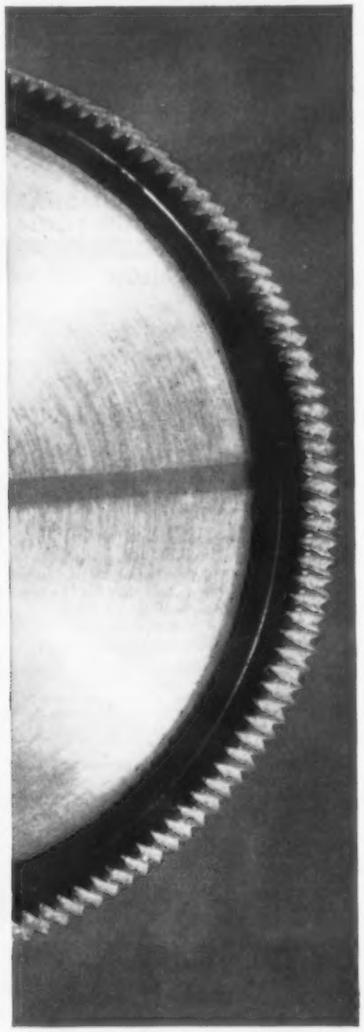
FOR THIS LITERATURE CIRCLE 165 ON READER-SERVICE CARD

counting controls for industry, defense and space exploration



Radar and missile-tracking systems incorporate Veeder-Root instrument counters for instant read-out of range, bearing and azimuth.

Flight instrumentation and navigation applications of Veeder-Root counters give jet pilots vital data in quick-reading digital display.



Military communication networks are integrated speedily through the use of Veeder-Root counters for indication of radio frequencies.

Locate, Navigate, Communicate . . . with Veeder-Root Counters. If you are developing any system which requires the rapid, accurate indication of essential information, investigate the proved advantages of digital read-out with specially engineered Veeder-Root instrument counters. In addition to comprehensive design cooperation, we can offer you manufacturing, testing and quality control facilities which are fully capable of meeting the most exacting military specifications. For information and assistance on military designs incorporating Veeder-Root counters, write Instrument Section, Veeder-Root Incorporated, Hartford 2, Conn. **count on . . . Veeder-Root**

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WITH THE REVOLUTIONARY PRODUCTION AID TOOL!

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Foot operated
No accessories
3 minute set up

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"PIG-TAILORING"

a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.

PIG-TAILORING eliminates: • Diagonal cutters • Long nose pliers • Operator judgment • 90% operator training time • Broken components • Broken leads • Short circuits from clippings • 65% chassis handling • Excessive lead tautness • Haphazard assembly methods.

PIG-TAILORING provides: • Uniform component position • Uniform marking exposure • Miniaturization spacing control • "S" leads for terminals • "U" leads for printed circuits • Individual cut and bend lengths • Better time/rate analysis • Closer cost control • Invaluable labor saving • Immediate cost recovery.

Pays for itself in 2 weeks

"SPIN-PIN"®

Close-up views of "SPIN-PIN" illustrate fast assembly of tailored-lead wire to terminal.

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- No Pliers
- No Clippings
- Uniform Crimps
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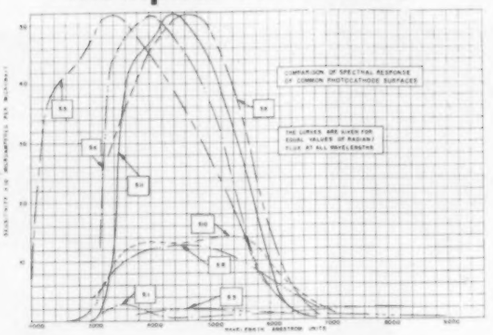
CIRCLE 81 ON READER-SERVICE CARD

Multiplier Phototubes



These charts . . . indicate the spectral responses of various photocathodes . . . The visible portion of the spectrum lies between 3800 and 7600 Augstroms with ultra-violet extending into shorter wavelength and infrared into longer wavelengths. . . (*From 6-page Form* 102, *Industrial Tube Sales Dept., Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J.*)

FOR THIS LITERATURE CIRCLE 166 ON READER-SERVICE CARD

True RMS Level Recorder

Typical reverberation decay curves measured in a long factory hall.

The Level Recorder Model 2305 is a basic instrument for measuring and recording the true rms, average or peak level of ac signals ranging in frequency from 10 c/s to 200,000 c/s and dc to 10 c/s signals through an internal chopper . . . The input voltage is fed to the interchangeable range potentiometer through a continuously variable input potentiometer and a calibrated input attenuator . . . (*From 8-page Brochure BK-2305, B & K Instruments, Inc., 3044 W. 106 St., Cleveland 11, Ohio.*)

FOR THIS LITERATURE CIRCLE 167 ON READER-SERVICE CARD

BOOK REVIEWS

TUNNEL DIODE MANUAL, by H. R. Lowry, J. Giorgis, E. Gottlieb and R. C. Weischedel, (1961) Semiconductor Products Dept., General Electric Company, Kelley Bldg., Liverpool, N. Y. 97 p., 5½" x 8½", $1.00. Theory, applications and test circuits are given for new tunnel diode device. Specifications for germanium tunnel diodes and for the germanium back diode, types 4JF2A-1 to 7, are included.

FOR THIS LITERATURE CIRCLE 168 ON READER-SERVICE CARD

PRECISION MEASUREMENT AND CALIBRATION—Electricity and Electronics, (1961) National Bureau of Standards, U. S. Department of Commerce, Government Printing Office, Washington 25, D. C., 840 p. 9" x 11½", $6.00. Compilation by Sherman F. Booth of previously published technical papers by staff of the National Bureau of Standards. Is Handbook 77, Volume I of three-volume set.

FOR THIS LITERATURE CIRCLE 169 ON READER-SERVICE CARD

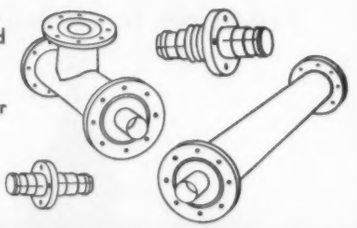
New FROM TACO

MICROWAVE ANTENNA SYSTEMS

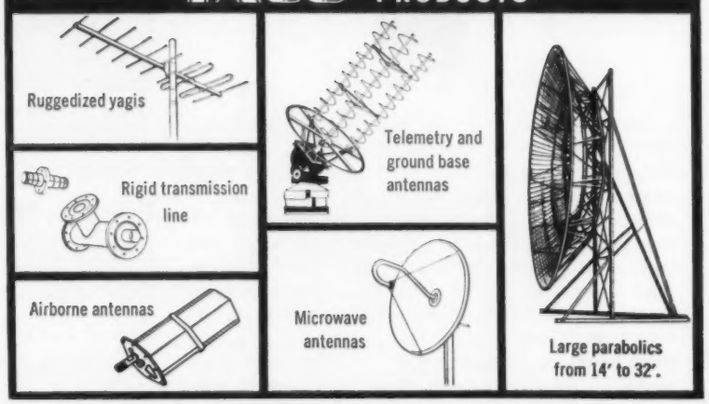
Now, the world's leading designer and manufacturer of fine antenna systems offers microwave antenna systems designed to fill the needs of industry and the military. All popular frequency bands, in all appropriate sizes from 4' to 12' diameter. Spun and mesh models. Choice of feed systems for plane or dual polarization. Everything you need for the best microwave antenna installation including mounts, anti-icing equipment, and accessories.

RIGID TRANSMISSION LINE

Complete rigid co-axial transmission line systems including EIA flange and Quick-Clamp types. Available in copper or aluminum. Special "BELLOWS-EXPANSION" bullet for long-run aluminum lines. Designed to meet the most critical needs of both military and commercial users. Includes ⅞", 1⅝", 3⅛", 6⅛" and 9" components.



TACO PRODUCTS



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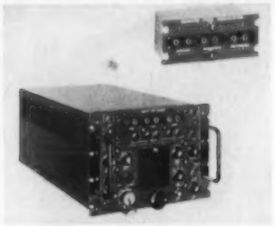
CIRCLE 82 ON READER-SERVICE CARD

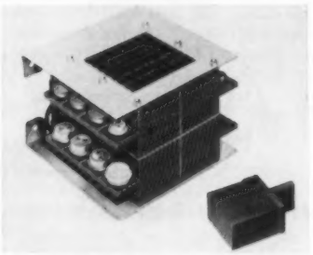
TIMING/TIME-ENCODER SET



New ETS-1 Electronic Timing Set compatible with mixed or multiple data systems controls up to 10 remote time indicators within ±1 sec/day, provides composite binary-code time signals and timing marker pulse trains for slow or fast-writing oscillographs, magnetic tape recorders, etc. Positive "turn on" and "turn off" signals from master oscillator control pulse rise times and pulse widths.—*Hallicrafters Co.*, 4401 *W. 5 Ave., Chicago* 24, *Ill.*

CIRCLE 170 ON READER-SERVICE CARD

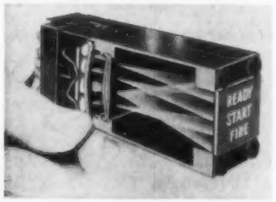
HEAT SINK



New Model 2401 modular aluminum Heat Sink uses light, compact, integrated blower and power transistors to dissipate almost 60 w at 25°C ambient. Thermal resistance between transistor shelf and air less than 0.8°C/w; mica washers unnecessary. Size and spacing of fins vary to match requirements of systems and blowers.—*Astro Dynamics, Inc.*, 200 *Sixth St., Cambridge* 42, *Mass.*

CIRCLE 171 ON READER-SERVICE CARD

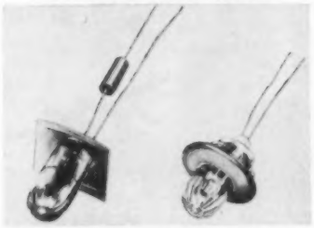
SUB-MINIATURE READOUT



New 3-½ oz Series 120000 Sub-Miniature Readout lamp projects colored words or background onto viewing screen at front of unit. Module construction, aluminum case.—*Industrial Electronic Engineers, Inc.*, 5528 *Vineland Ave., North Hollywood, Calif.*

CIRCLE 172 ON READER-SERVICE CARD

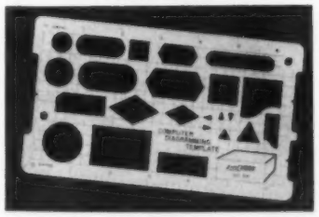
INDICATOR ASSEMBLIES



New "Econoglo" Neon Glow Indicator Assemblies with Tinnerman nut or snap-in plug mount from front of panel, are available with built-in current-limiting resistors. Plain, fluted, or flatcap lens.—*Drake Manufacturing Co.*, 4626 *N. Olcott Ave., Chicago* 31, *Ill.*

CIRCLE 173 ON READER-SERVICE CARD

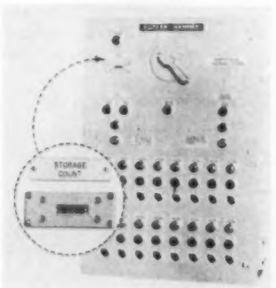
COMPUTER DIAGRAM TEMPLATE



New No. 54 Computer Diagramming Template for drawing work flow charts and block diagrams in computer programming has two sizes of symbols for decisions, switches, operations, etc. Measured off in .250 grid; has one scale in 10ths, one standard, 6 lines/in; measures 7" x 4".—*Rapidesign Inc., Box* 429, *Burbank, Calif.*

CIRCLE 174 ON READER-SERVICE CARD

COUNTERS



New Durant 5-Y-8602-MF Counters used on incoming and outgoing "Mail-Flo" master panels control inventory of mail trays put in and taken from storage, have add and subtract feature, "up-front" readability. Operating coil totally enclosed and fully protected; entire unit can be panel mounted from front. ½—*Durant Manufacturing Co.*, 1949 *N. Buffum St., Milwaukee* 1, *Wis.*

CIRCLE 175 ON READER-SERVICE CARD

CIRCLE 83 ON READER-SERVICE CARD →

...*for* **MINIATURIZATION**

LOW FRICTION and WEAR
LASTING PRECISION ALIGNMENT
ELIMINATE BINDING and CHATTER
ZERO SHAKE or PLAY
LONG LIFE — LOW MAINTENANCE
SOLVES SLIDING LUBRICATION PROBLEMS

Used by progressive engineers in the latest guidance, fire control and navigation systems, computers, inertial devices, instruments.

Various types of* BALL BUSHINGS *are made for shaft sizes from ⅛" to 4"... with small sizes available in Stainless Steel. Write for literature and name of our representative in your city.

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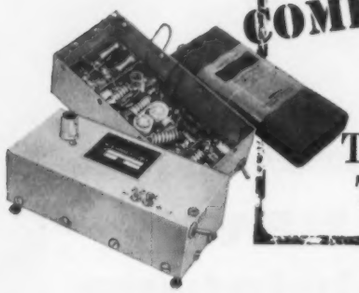

COMPACT-RUGGED

UHF TELEMETERING TRANSMITTER

NEW TT-1001 UHF TELEMETERING TRANSMITTER gives accurate and stable CW Signal for radio direction finder tracking of missiles or vehicles. Unit is completely transistorized with a self-contained regulated power supply. Easily installed, high accuracy and stability under extreme environment. Write for Bulletin 101-C.

- Low power drain, fully solid state
- WT: 6.5 oz. w/o battery
- Frequency: 225-245 m.c.
- Power Output: 260 milliwatts

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Electroplated WIRES

SINCE 1901

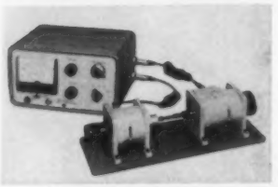
Wires for electrical contacts in a wide range of diameters may be plated with Rhodium, Gold, or Platinum. Electrical contacts, capable of handling currents at very low voltages, can be made with utmost reliability. The precious metals do not form an insulating barrier of oxides as would be the case with base metals.

Write for Latest Brochure

SIGMUND COHN MFG. CO., INC.
121 SOUTH COLUMBUS AVENUE, MOUNT VERNON, N.Y.

CIRCLE 85 ON READER-SERVICE CARD

GEAR ANALYZER



New Gear Analyzer permits observation of shaft backlash angle due to alternately applied clockwise and counterclockwise torque, permits detection of minute shaft motion while determining breakaway torque from 0.002 to 48 oz-in. Mounting adapters accomodate gear heads, servo systems, etc.—*Rotiform Co.*, 1509 *Colorado Ave., Santa Monica, Calif.*

CIRCLE 176 ON READER-SERVICE CARD

DIGITAL SHAFT ENCODER

New Vernisyn miniature high accuracy digital shaft encoder, Type VS-256E, in 1½" dia by 2" length, including electronics, gives resolutions as required of one part in 2^{14}, 2^{15}, and 2^{16} in single turn. Accuracy is maintained in slew rates from 16 min/sec to 2° sec without time correction.—*Data Tech*, 238 *Main St., Cambridge* 42, *Mass.*

CIRCLE 177 ON READER-SERVICE CARD

TUNING FORK OSCILLATOR

New Transistorized Oscillator uses temp-compensated fixed-frequency tuning fork to give frequency ac-

curate to ±0.002% over 0° to 65°C for any combination of voltage, attitude and age variables. Prime frequency range of 360-6000 cps (other ranges available). Output signal can exceed 3-v rms, sine wave or square wave, across 10-K load (or any special output voltage to 0.1-w power).—*Fork Standards, Inc.*, 1915 *N. Harlem Ave., Chicago* 35, *Ill.*

CIRCLE 178 ON READER-SERVICE CARD

COMPUTER POWER SUPPLY

New Solid State Power Supply provides voltages for operating computer system complex containing 6 to 32 different regulated d-c supplies, integrated with common control system to reduce number of parts and overall space and weight. Features include solid state components utilizing magnetic amplifiers with heavy overload capabilities, with semi-conductors superimposed for intermittent light duty and for fast response in suppressing line and load transients. Bulletin S1023.—*Magnetic Amplifiers Div., Siegler Corp.*, 632 *Tinton Ave., New York* 55, *N. Y.*

CIRCLE 179 ON READER-SERVICE CARD

PRE-AMPLIFIER

New 2⅞" x 1⅛" Amplifier consists of transistor circuitry mounted on printed circuit board and potted with-

in standard 14-pin image orthicon base socket. Signal-to-noise ratio held to 60 db when output level is 1-v peak to peak. Amplifier compensated for IO having 18-$\mu\mu$f output load capacity across 68 Kilohms.—*Dage Div., Thompson Ramo Wooldridge Inc., Michigan City, Ind.*

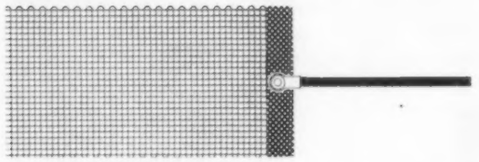
CIRCLE 180 ON READER-SERVICE CARD

DELAY LINE

New Delay Line 2M1-5/5 achieves 10:1 size and weight reduction by having 2 coils wound on each subminiature toroidal core and using tem-conpensating ceramic disc capacitors. Attenuation of 1% (0.008 db), total delay 0.2 μsec, rise time 0.04 μsec, size 0.25" x 0.4" x 1.75".—*Valor Instruments, Inc.*, 13214 *Crenshaw Blvd., Gardena, Calif.*

CIRCLE 181 ON READER-SERVICE CARD

Wire Mesh Heating Elements

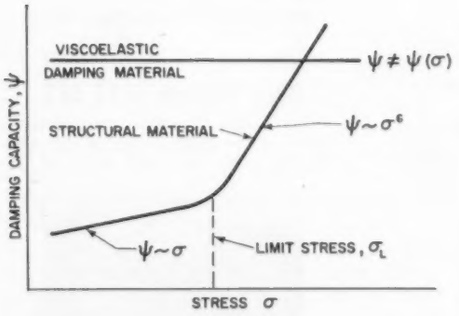


The interconnecting electrical conductors give the "Electromesh" Heating Element a degree of reliability not achieved in any other form of electrical heating. In the event of a broken current-carrying wire, the cross wire acting as an equi-potential redistributes the current around this partial open circuit, restoring the element to full power.

Likewise, the multi-stranded principle of Electromesh utilizes the reliability of many parallel circuits rather than relying on a single wire in series circuit . . . It is extremely flexible, light weight (⅓ lb. per sq. ft.) and thin (.040", including insulation). It is easily adaptable to fit the most complicated hard-to-fit surfaces and in many cases can be formed to actually substitute for the part itself, thus saving not only space and weight, but production costs as well . . . (*From* 16-*page catalog, Electrofilm, Inc.,* 7116 *Laurel Canyon Blvd., North Hollywood, Calif.*)

FOR THIS LITERATURE CIRCLE 182 ON READER-SERVICE CARD

Specification of Structural Damping



There are various methods of specifying the amount of damping that exists in an engineering material or a structural fabrication. The *specific damping energy* D (in lb/in^3/cycle) of a material represents the area within the stress-strain hysteresis loop for uniform stress conditions . . . The *damping capacity* Ψ is defined as the ratio of the total damping energy D_o to the maximum potential energy W_o (in-lb/cycle) developed during a completely reversed vibration cycle: $\Psi = D_o/W_o$ . . . (*From* 52-*page report, "New Design Techniques for Damping Structural Resonances," Barry Controls, Inc.,* 700 *Pleasant St., Watertown* 72, *Mass.*)

FOR THIS LITERATURE CIRCLE 183 ON READER-SERVICE CARD

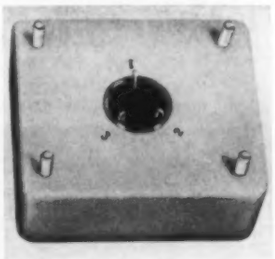
AMPLIFIER

New Type A102S Feedback Amplifier, 1¼" x 1⅛" x 2½", is transistorized, has more than 40-db degeneration. Amplification stable at 100, from 1 cps to 15 kc. Unit self-powered, completely shielded, non-microphonic, no hum.—*Ad-Yu Electronics Lab., Inc.,* 249-259 *Terhune Ave., Passaic, N. J.*

CIRCLE 184 ON READER-SERVICE CARD

DELAY LINES

New Lumped Constant Delay Lines consist of m-derived LC networks. Each delay lines section gives linear phase shift beyond 70% cutoff frequency. Thermal stability less than 0.05%/°C; operating range −25° to 125°C. Bulletin NPB-108.—*HST Div., Dresser Electronics,* 555 *N.* 5 *St., Garland, Texas.*



CIRCLE 185 ON READER-SERVICE CARD

TRANSPONDER DELAY LINE

New Model 52-44 miniature (1" x 2" x 3") Transponder Delay Line has 470-ohm impedance, 20.3 ±0.1 μsec delay time, 0.6 μsec max rise time, 4-db attenuation, temp coefficient of 65 ppm or better from −55° to +125°C.—*ESC Electronics Corp.,* 534 *Bergen Blvd., Palisades Park, N. J.*

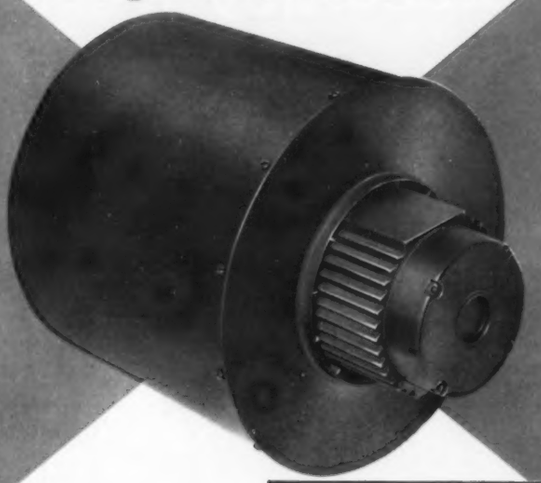
CIRCLE 186 ON READER-SERVICE CARD

LOW-NOISE CHOPPERS

New 60 and 400 cps low-thermal-noise instrument choppers reduce thermal emf's less than 0.5 μv over normal operating temperature range of 0°C to 55°C. Data on techniques and use available.—*James Electronics Inc.,* 619 *N. Michigan Ave., Chicago* 11, *Ill.*

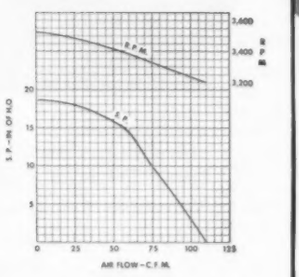
CIRCLE 187 ON READER-SERVICE CARD

the pressure's on for '61



MULTI-STAGE BLOWER

60 cps or 400 cps
1ϕ or 3ϕ
To 440 Volts
10" O.D. by lengths up to 14"
Ambient Range: −55° + 85° C
Commercial or Military



MULTISTAGE BLOWER
60 cps — 6 Stages

When engineering specifications require continuous duty and quiet long life, Air Marine offers multistage blowers for low volume, higher pressure applications to 1 psi with air delivery to 100 CFM. Featured is long life with low noise. Where high pressure is required or on such vacuum applications as tape retention, the Air-Marine multistage blowers are the efficient answer.

Our field engineers will gladly assist you in the selection and application of motors, blowers or fans.

Air Marine motors, blowers and fans have been designed and tested to meet the specifications of both the military and industry.

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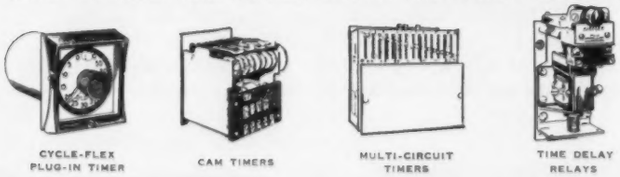
In Canada AAE Limited, Weston, Ontario

CIRCLE 86 ON READER-SERVICE CARD

The EAGLE Microflex Timer provides unequaled accuracy in closing or opening a circuit. An easy-to-read 20 turn double micrometer dial speeds the selection of new settings over full 7200° range and permits a one-glance check of previously set intervals.

- PIN-POINT ACCURACY is possible with 1200 conveniently spaced dial markings. No guessing at in-between points. Accuracy maintained by patented pinion and threaded axle.
- 9 DIFFERENT ACTIONS are available for each of 3 SPST 15 ampere contacts which can be selected according to circuit requirements.
- PLUG-IN COMPONENTS allow rapid replacement of timers. Large capacity contacts eliminate additional load relays.

OTHER POPULAR HIGH QUALITY EAGLE TIME-COUNT CONTROLS



CYCLE-FLEX PLUG-IN TIMER | CAM TIMERS | MULTI-CIRCUIT TIMERS | TIME DELAY RELAYS

For more details on the Microflex Timer, write for free bulletin 110, or contact your local Eagle Representative listed in Thomas Register or Phone Directories in 25 principal cities.

BLISS

EAGLE SIGNAL COMPANY • Moline, Illinois

A DIVISION OF THE GAMEWELL COMPANY, AN E. W. BLISS COMPANY SUBSIDIARY

MANUFACTURERS OF THE MOST COMPLETE LINE OF INDUSTRIAL TIME-COUNT CONTROLS

CIRCLE 87 ON READER-SERVICE CARD

LUMPED-CONSTANT DELAY LINES

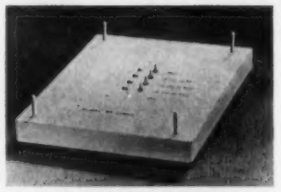
New DL-1175 (1 of new DL-100 Series Delay Lines) has 175-μsec total delay, 1.0-μsec rise time, giving

Delay/Rise Time Ratio of 175:1. Series offers delays to 500 μsec, impedances from 100-1000 ohms, operating temp −55° to 125°C.—*Allen Avionics, Inc.*, 255 *E. 2 St., Mineola, L. I., N. Y.*

CIRCLE 188 ON READER-SERVICE CARD

DELAY LINES

New Type 159 Delay Line, housed in metal, slab-shapped case, works on magnetostrictive principle; has three



outputs of fixed delay: 30.00 μsec and two others. Pulse repetition rate 615 kc, input pulse width 0.8 μsec; input and output impedance 500 ohms; insertion loss approx 50 db.—*Deltime, Inc.*, 139 *Hoyt St., Mamaroneck, N. Y.*

CIRCLE 189 ON READER-SERVICE CARD

SHAFT-ANGLE ENCODER

New non-contracting Gray code magnetic Shaft-Angle Encoder (Bu-Ord size 18, synchro mount) provides

accurate readout at 10,000 rpm, has low starting and running torques, has non-ambiguous code and is mechanically interchangeable with existing brush-type encoders.—*Norden Div., United Aircraft Corp., Norwalk, Conn.*

CIRCLE 190 ON READER-SERVICE CARD

AC/DC PREAMPLIFIER

New 458B/N chopper-stabilized, single-ended, wideband d-c Amplifier provides 4 modes of operation. Unit

consists of 458B phase-inverting amplifier (with improved frequency response and gain accuracy from dc to 2 kc when amplifier is set to gain of 100) mounted in 458N module.—*Kin Tel Div., Cohu Electronics, Inc.*, 5725 *Kearny Villa Rd., Box* 623, *San Diego* 12, *Calif.*

CIRCLE 191 ON READER-SERVICE CARD

AUDIO DELAY LINE

New Type L894C precision Audio Delay Line with delay of 5000 μsec ±1% features phase linearity of

±0.1% in center frequency band from 3050 to 3550 cps; phase linearity to cut-off ±0.2%. Impedance of 600 ohms; low-frequency insertion loss 1.5 db; attenuation 3 db at 3.5 kc, 6 db at 4.8 kc.—*Columbia Technical Corp.*, 61-02 31*st Ave., Woodside* 77, *N. Y.*

CIRCLE 192 ON READER-SERVICE CARD

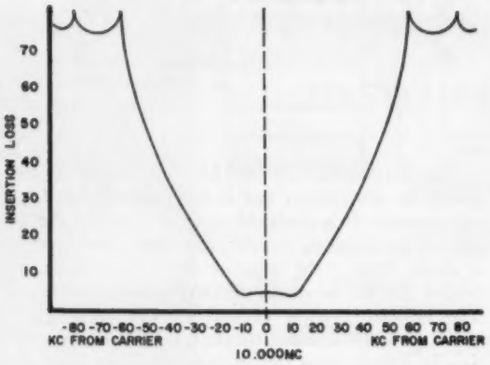
GRID REGION TEST SET

New 5-Mw Positive Grid Region Test Set for high power triodes and tetrodes has peak grid pulse of 10

kv, 500 amp at 2 μsec; pulse repetition rate adjustable from "one shot" to 60 pps; 75-kw forced air-cooled, non-inductive resistor provided as plate load for tube under test.—*FXR, Inc., High Power Electronics Div.*, 25-26 50*th St., Woodside* 77, *N. Y.*

CIRCLE 193 ON READER-SERVICE CARD

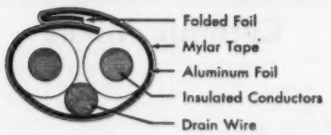
Band-Pass Filter



Developed for application in transistorized IF amplifiers. Designed to operate from −55°C to +65°C in a salt laden atmosphere. This compact filter (Model BP-10000-36) is capable of withstanding 50G shock. The unit is hermetically sealed and made to meet applicable MIL specifications . . . (*From set of 8 data sheets, Systems Inc., 2400 Diversified Way, Box 7726, Orlando, Fla.*)

FOR THIS LITERATURE CIRCLE 194 ON READER-SERVICE CARD

New Cable Shield



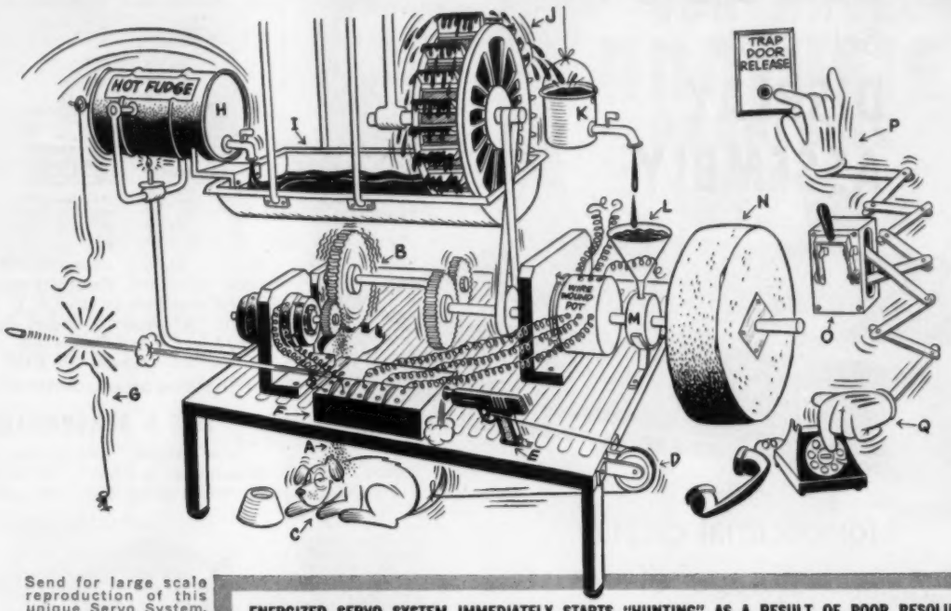
Beldfoil is a Belden development and a major breakthrough in the search for quiet cables. By laminating aluminum foil with Mylar, a shield with maximum effectiveness is combined with a high dielectric strength insulation. For multi-paired cables with each pair separately shielded, the Mylar is applied outside with an inward folded edge to obtain isolation between the shields on adjacent pairs. Diagram . . . shows how each pair is shielded . . .

For certain two and three conductor Beldfoil shielded cables, the Mylar is applied inside with an outward folded edge which gives the table an additional 1500-volt insulation barrier . . . (*From 34-page Electronic Wire and Cable Catalog, Wire and Cable Div., Western International Co., 45 Vesey St., New York 7, N. Y.*)

FOR THIS LITERATURE CIRCLE 195 ON READER-SERVICE CARD

For More Information on Products Listed Circle Appropriate Number on Reader-Service Card

HERE'S ONE WAY TO SOLVE SERVO "HUNTING" PROBLEMS...



Send for large scale reproduction of this unique Servo System.

ENERGIZED SERVO SYSTEM IMMEDIATELY STARTS "HUNTING" AS A RESULT OF POOR RESOLUTION WIRE-WOUND POT. METALLIC DUST (A), CREATED BY WEARING DOWN OF OSCILLATING GEARS (B) IN "HUNTING" SERVO SYSTEM, FALLS UPON HEAD OF OFFICE DOG (C). DOG ENJOYS PLEASANT SENSATION AND PROCEEDS TO HAPPILY WAG TAIL. STRING ATTACHED TO DOG'S TAIL RUNS AROUND PULLEY WHEEL (D) AND ACTUATES TRIGGER OF "AUTOMATIC GAIN KILLER" (E) ATTACHED TO AMPLIFIER (F). [FIRST STEP IN REDUCING SERVO HUNTING.] PROJECTILE, AFTER LEAVING AMPLIFIER, BREAKS STRING (G) THEREBY ALLOWING DRUM (H), FILLED WITH SPECIAL VISCOUS DAMPING FLUID, TO TILT FORWARD. FLUID FLOWS INTO TROUGH (I). DAMPING PADDLE WHEEL (J) TAKES EFFECT. [SECOND STEP IN REDUCING SERVO HUNTING.] EXCESS FLUID ON PADDLE WHEEL DRIPS INTO RESERVOIR (PAINT CAN—K), THEN PASSES THROUGH FUNNEL (L) INTO FLUID CLUTCH (M) CONNECTING SCIENTIFICALLY SELECTED INERTIAL LOAD (GENUINE MILLSTONE, ON LOAN FROM SMITHSONIAN INSTITUTE—N.) [FINAL STEP IN REDUCING SERVO HUNTING.] IF SYSTEM STILL "HUNTS"—ENGINEER THROWS EMERGENCY SWITCH (O) ACTIVATING HAND (P) WHICH PRESSES TRAP DOOR RELEASE, DUMPING ENTIRE SYSTEM INTO LOCAL RIVER (NOT SHOWN). HAND (Q) PROCEEDS TO DIAL C.I.C.'S PHONE NUMBER (IVANHOE 3-8200) FOR AN INFINITE RESOLUTION "NON-HUNTING" FILM POT.

- INFINITE RESOLUTION
- INHERENT RELIABILITY
- PRECISION LINEARITY
- LOW OPERATIONAL NOISE
- MULTI-MILLION CYCLE LIFE
- VIDEO FREQUENCY OPERATION

BUT THE BEST WAY YET...

Use C. I. C. Film Pots for High Performance Servo Systems!

Not only do **C. I. C.** Film Pots offer the infinite resolution necessary to eliminate servo hunting problems, but they guarantee you the greatest linearity possible in any given size or diameter. They provide the reliability inherent in a single broad band film element as opposed to the high failure rate of today's wire wound pots. **C.I.C.** Film Pots do even more... They actually run as high as 1000 rpm and still retain reliability, while assuring many millions of cycles of operation.

COMPUTER INSTRUMENTS CORPORATION
92 MADISON AVENUE • HEMPSTEAD, L. I., NEW YORK

FIRST IN FILM POTS
CIC

CIRCLE 88 ON READER-SERVICE CARD

NEW!

Solid State

DISPLAY ASSEMBLY

for decimal display and storage of binary coded decimal data

accepts up to 24 bits of parallel BCD data

Hermes' new Solid State Display Assembly, Model 2060, is designed for use in any system requiring presentation in decimal display of a BCD parallel signal. For example, Model 2060 permits direct reading of Angular Shaft Encoders with BCD parallel output. Model 2060 accepts up to 24 bits of parallel BCD information in any of the following 4-bit Codes: Binary Code Decimal (1-2-4-8); Gray Code (Cyclic Code); Decade Counter Code (1-2-2-4) or (1-2-4-2); Binary Complement Coded Decimal; Binary Two Out of Five Code; Binary (1-2-4-7).

These signals are converted to 60-line decimal display using Burroughs-type Nixie tubes. Binary input to Model 2060 may be either static or parallel pulses.

Storage capability which can conveniently be retrieved through a multi-pin connector is provided in the converting circuitry. Converter Boards can be furnished which accept up to six bits of parallel information, converting to two decimal displays. *Write for Technical Bulletin 2060.*

Hermes

ELECTRONICS CO.

75 CAMBRIDGE PARKWAY, CAMBRIDGE 42, MASS.

A DIVISION OF Itek

CIRCLE 89 ON READER-SERVICE CARD

MOTOR-TACHOMETER

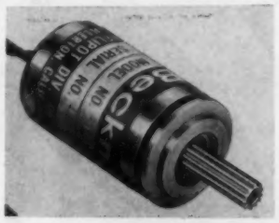
New instrument Servo Motors and Motor-Tachometers are as much as ⅓ shorter than conventional models

having similar characteristics, feature increased electrical efficiency. Units available in sizes 8, 10 and 11; fulfill MIL-specs.—*Cedar Engineering, Div. Control Data Corp.*, 5806 *W.* 36 *St., Minneapolis* 16, *Minn.*

CIRCLE 196 ON READER-SERVICE CARD

SIZE 5 SERVOMOTOR

New Model 9005-1502-0 Size 5 Servomotor is 0.865" long, weighs 0.6 oz. Powered by 26-v, 400-cycle refer-

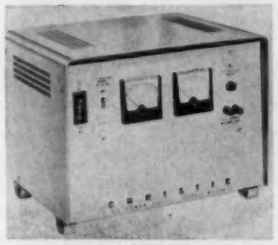


ence voltage; no-load-speed of 10,000 rpm, torque-at-stall 0.1 oz-in, rotor inertia 0.18 gm cm², acceleration-at-stall 39,000 rad/sec².—*Helipot Div., Beckman Instruments, Inc.*, 2500 *Harbor Blvd., Fullerton, Calif.*

CIRCLE 197 ON READER-SERVICE CARD

50-AMP SUPPLY

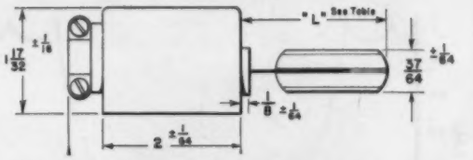
New compact, general purpose Power Supply delivers 50-amp for 1 min or 30 amp continuous duty, with volt-



age adjustment range of 2-36 v, ±0.5% voltage regulation and 1% rms ripple. Model BC236-30 uses silicon-controlled rectifiers; Model BC236-30B provides for automatic charging of lead-acid and nickel-cadmium batteries.—*Christie Electric Corp.*, 3410 *W.* 67 *St., Los Angeles* 43, *Calif.*

CIRCLE 198 ON READER-SERVICE CARD

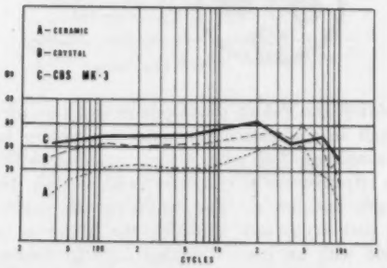
Airflow Interlock Switch



The Rotron Model 2A Airflow Switch actuates purely on air velocity and is not influenced by static air pressure. It is designed to mount against the outside of an air duct (round or flat surfaces) and has a small, lightweight stainless steel vane which protrudes into the airstream through a hole in the duct. The velocity-pressure exerted by the airstream on the vane is transmitted through a thin stainless steel arm to a snapaction switch inside the switchbox. Unlike pressure-operated devices, these velocity-operated interlock switches will de-actuate whenever the airstream decreases due to slow accumulation of dust deposits in the air circuit upstream of the switch. Such deposits will easily accumulate between the fins of finned-anode forced air cooled tubes and of heat exchangers. Dust filters retard such pollution but never completely eliminate it . . . (*From* 4-*page Catalog Sheet* 90201-1*B*, *Rotron Mfg. Co., Inc., Schoonmaker Lane, Woodstock, N. Y.*)

FOR THIS LITERATURE CIRCLE 199 ON READER-SERVICE CARD

Ceramic Mikes



Ceramic microphones overcome the problems of heat and humidity by using a crystalline substance which is fired in the making, and is thereafter unaffected by heat or moisture . . . Sound pressure moves the diaphragm in and out and this motion is transmitted by a connecting linkage to one end of the ceramic element. The other end of the element is clamped securely in place. This produces a bending force on that part of the ceramic element which is outside of the clamped area. As the ceramic element is stressed, tension develops on the opposite side. This produces a voltage between the two sides which are insulated from each other by the ceramic material itself. This voltage is proportional to the amount of stress and the area over which the stressing occurs . . . (*From* 4-*page Bulletin PA*-504, *CBS Electronics, Div. Columbia Broadcasting System, Inc., Danvers, Mass.*)

FOR THIS LITERATURE CIRCLE 200 ON READER-SERVICE CARD

ELECTRONIC COMPONENT PARTS

hi-reliability

Custom fabrication of all insulating materials to commercial and government specs. Assembly of components on printed circuits, resistor and terminal boards for all microwave and other electronic applications. Terminals manufactured to military and commercial specifications. Tip, Banana, Telephone Plugs and Jacks from stock.

Write for New Catalog!

RESISTOR and TERMINAL BOARDS

Custom terminal board assemblies to commercial or government specs.

TIP, BANANA, TELEPHONE PLUGS and JACKS — TEST PROBES

Complete standard line available.

DIODE MOUNTING BASES

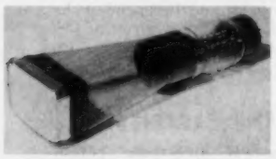
Custom made of spring brass and any insulating material to customer specs.

NATIONAL TEL-TRONICS CORPORATION
52 ST. CASIMIR AVENUE — YONKERS, NEW YORK
Phone: YOnkers 8-6400

CIRCLE 90 ON READER-SERVICE CARD

CATHODE-RAY TUBE

New 7BFP triple-beam 4" x 6" rectangular Cathode-Ray Tube (shown) is electrostatically focused and deflected; each beam (independently controllable with common accelerator and heater connections) scans separate screen area, permitting three simultaneous displays. New Type 5BWP Tube with 5"-dia face plate has spiral linear post accelerator from tube face to deflection plate region allowing for gradual voltage gradient.—*Electronic Tube Div., Allen B. Du Mont Laboratories, Division of Fairchild Camera and Instrument Corp., Clifton, N. J.*



CIRCLE 201 ON READER-SERVICE CARD

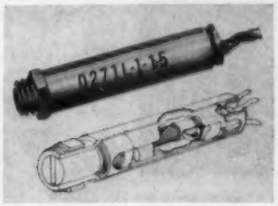
MULTITURN POTENTIOMETER

New Series 3700 1¾"-dia Potentiometers feature unitized rotor design to yield smoother operation while reducing moment of inertia.—*Duncan Electronics, 1305 Wakeham Ave., Santa Ana, Calif.*

CIRCLE 202 ON READER-SERVICE CARD

SLIDEWIRE TRIMMING POT

New 0.250"-dia. x 1.325" slide wire unit trims, balances and calibrates circuits. Specs: power rating of ¼ w at 50°C, derate to 0 at 125°C; temp range of −55° to +125°C; resistance range of 3 to 17 ohms; meets mil specs.—*Con-Elco, Div. Edcliff Instruments, 1711 S. Mountain Ave., Monrovia, Calif.*



CIRCLE 203 ON READER-SERVICE CARD

FIELD MONITOR-ALARM

New MCU-7 Monitor-Alarm System, transistorized and ruggedized for field operation, monitors 30 or more channels of intermixed analog data representing pressures, temps, voltages, displacements.—*Communications Control Corp., 14707 Keswick St., Van Nuys, Calif.*

CIRCLE 204 ON READER-SERVICE CARD

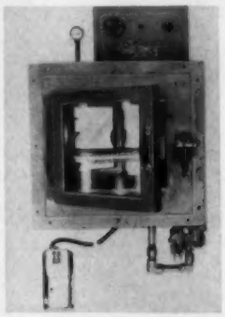
6PDT CRADLE RELAYS

New inexpensive Cradle Relays up to 6PDT come in 3 types—open, hermetically sealed, or with flame-resistant polycarbonate dust covers. Plug-in mountings mate with commercial 20-pin miniature sockets. Contact rating, 2-amp resistive, 1-amp inductive at 29-v dc or 115-v ac.—*Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.*

CIRCLE 205 ON READER-SERVICE CARD

VACUUM OVEN

New Model 722-M Vacuum Oven with foot-operated, electric 3-way valve simplifies vacuum and gas flush operation. Double doors permit pass through workload for dry box applications. Chamber (10" x 14" x 10") evacuates down to 1 micron.—*Electric Hotpack Co., Inc., 5061 Cottman Ave., Phila. 35, Pa.*



CIRCLE 206 ON READER-SERVICE CARD

INDUCTION MOTOR

New A-10-11 high temp, split-capacitor Motor operates continuously from −55° to +125°C. Can drive either vane axial or propeller type fan for cooling electronic chassis. Features: 1/400 hp; 115 v, 400-cps, 3 ϕ voltage; 10,500 rpm speed; 0.24 oz-in starting torque. Meets mil specs.—*Kearfott Div., General Precision Inc., 1150 McBride Ave., Little Falls, N. J.*

CIRCLE 207 ON READER-SERVICE CARD

DO YOU HAVE ANALYSIS PROBLEMS

SPECTRUM, NOISE, VIBRATION, PULSE, SSB, FILTERS, MODULATION, DISTORTION, TELEMETERING

?

Telemetering.....Models TA-100L, TA-120L; 12 cps to 120 KC; 350 cps to 120 KC
Ultrasonic.....Model SS-500; 75 cps to 600 KC
Supersonic.....Model SS-100; 13.5 cps to 110 KC
Sonic.....Model SS-20; 6 cps to 23 KC
Subsonic.....Model SS-5; 1 cps to 5.3 KC
SSB.....Model MD-500; 500 KC to 1000 MC

LET PROBESCOPE SPECTRUM ANALYZERS SOLVE THEM

Synchronous Sweep Generators
Frequency Range Extenders
Sweep Range Extenders
Signal Alternators

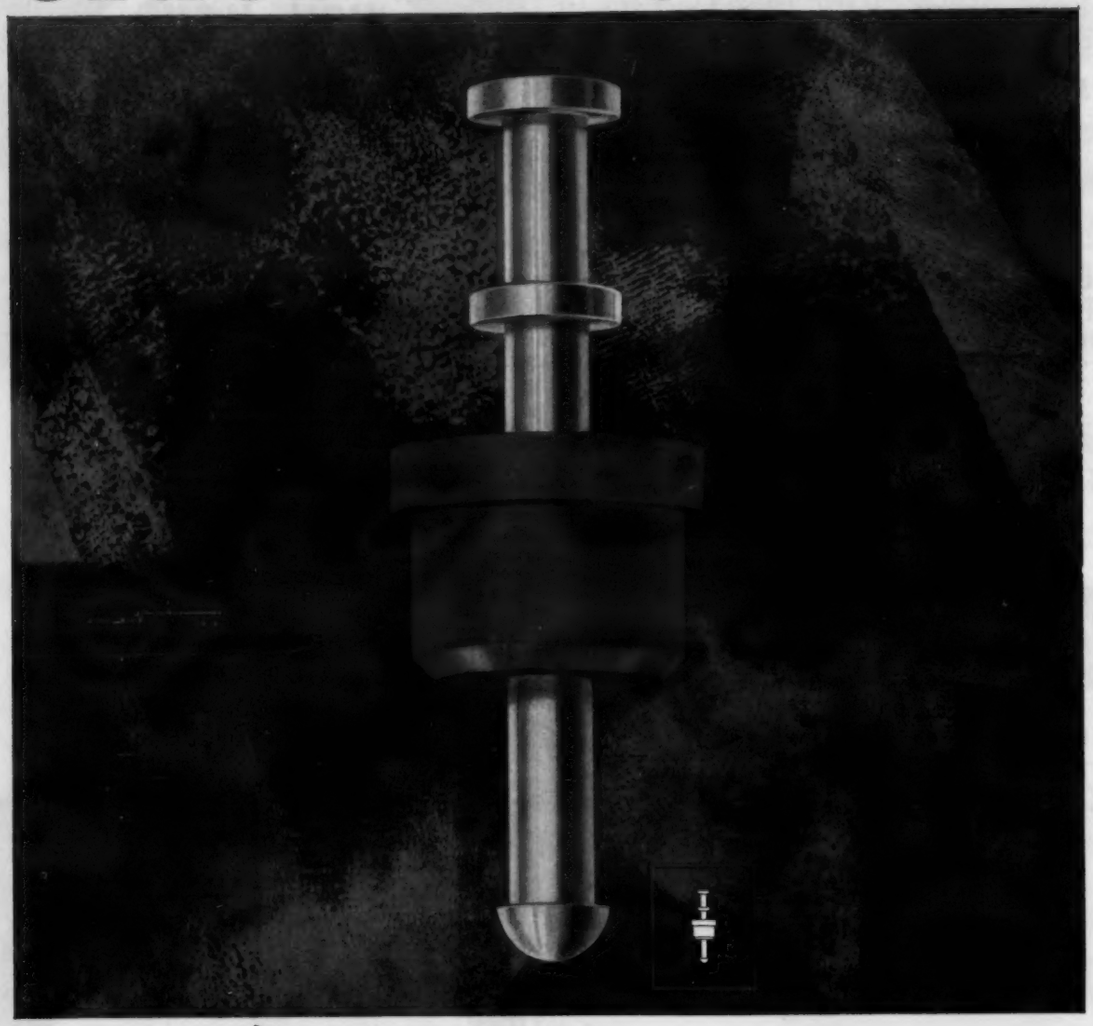
Write or phone for complete specifications PO 7-8150

PROBESCOPE

PROBESCOPE COMPANY, INC.
8 SAGAMORE HILL DRIVE, PORT WASHINGTON, N. Y.

CIRCLE 91 ON READER-SERVICE CARD

ORIGINAL QUALITY



THIS IS "PRESS-FIT®" Cat. No. FT-SM-1-TUR

Simple? No. In spite of their appearance, Sealectro "Press-Fit" Teflon* terminals represent thousands of hours of engineering design and research, ultra-critical inspections of materials and finished products, precise workmanship, and customer services beyond that of many complex electronic assemblies. A Sealectro "Press-Fit" terminal is more than a component. It is a symbol of dependability. When specifying Teflon terminals, always specify the original quality—Sealectro "Press-Fit" Teflon terminals, and be sure of every single one. Write for Complete catalog...

*Reg. T.M. of E. I. DuPont de Nemours & Co., Inc.

Sealectro and only Sealectro

MAKES "PRESS-FIT" TEFLON TERMINALS

SEALECTRO CORPORATION, 139 HOYT STREET, MAMARONECK, N. Y.

British Branch: Sealectro Corporation, Hersham Factory Estate, Lyon Road, Walton-on-Thames, Surrey, England.

CIRCLE 92 ON READER-SERVICE CARD

ELECTRONIC GENERATOR

New Model M 1435D Generator has output of 2000 va, integrates into 2- and 3-phase systems. Specs: 50-20,000

cps frequency range, ±0.001% frequency stability, ±1.0% voltage regulation, less than 1.0% distortion.—*Communication Measurements Lab., Inc., Subs. Tenney Engineering, Inc., 350 Leland Ave., Plainfield, N. J.*

CIRCLE 208 ON READER-SERVICE CARD

ILLUMINATED SWITCH

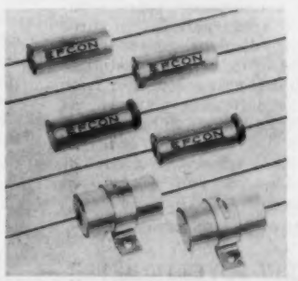
New illuminated, push-button panel Switch for ground support equipment and industrial control and monitor-

ing systems features momentary or alternate action, front lamp replacement, double-throw switching from 2 to 4 poles, uniform illumination with 6 and 28-v lamps, and independent or switch wiring for lamp circuits.—*O & S Research, Inc., Riverton, N. J.*

CIRCLE 209 ON READER-SERVICE CARD

HIGH-TEMP CAPACITORS

New Type TH high-temp Teflon dielectric capacitors feature high insulation resistance, low dielectric ab-

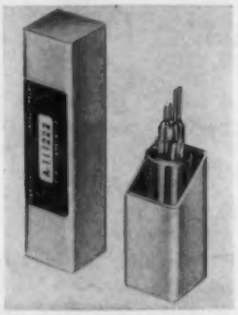


sorption, low dissipation factor, small capacitance with temperature. Operating temp range −55° to 200°C. Meet MIL Specs.—*Efcon, Inc., Patterson Place, Roosevelt Field, Garden City, L. I., N. Y.*

CIRCLE 210 ON READER-SERVICE CARD

MERCURY-WETTED RELAYS

New mercury-wetted Relay modules mount on printed circuit boards. Standard HG or super-sensitive HGS

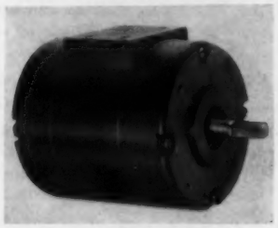


switch capsules potted in plated steel; coils individually wound to meet customer specs. Bulletin CPC-8.—*C. P. Clare & Co.*, 3101 *Pratt Blvd., Chicago* 45, *Ill.*

CIRCLE 211 ON READER-SERVICE CARD

AC MOTORS

New "G Frame" series a-c Motors offer hp rating from 1/400 to 1/4, synchronous induction or hysteresis,

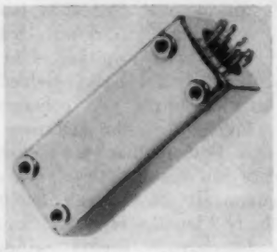


1 or 3 phase, 2 or 4 pole speeds, −55° to +125°C ambient range. Finned version has 3-3/4" dia; plain unit, 3-5/16" dia.—*Air Marine Motors, Inc., Bayview Ave., Amityville, L. I., N. Y.*

CIRCLE 212 ON READER-SERVICE CARD

LOW-FREQUENCY OSCILLATOR

New FS-1001 F vibration-resistant low frequency crystal Oscillator has electrical frequency as low as 8 kc,

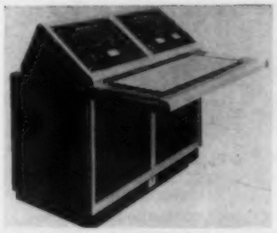


stability of ± 0.025% from −55° to +100°C, rise and fall time of 10 μsec. Vibration is 30 g's from 20-2,000 cps; shock is 70 g's for 11 msec.—*Monitor Products Co.*, 815 *Fremont, South Pasadena, Calif.*

CIRCLE 213 ON READER-SERVICE CARD

CIRCUIT ANALYZER

New Model 20 AC-DC Automatic Circuit Analyzer tests a-c and d-c wiring harness and electrical cabling,

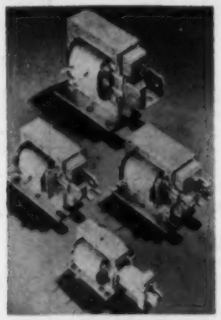


detects dead shorts instantly with no damage to cable. Dwell time fully adjustable; compensation for accumulated circuit capacitance provided. Testing capacity 200 circuits, can be expanded to 400 or 800 circuits.—*DIT-MCO, Inc.*, 911 *Broadway, Kansas City, Mo.*

CIRCLE 214 ON READER-SERVICE CARD

SOLENOIDS

New Super-T laminated Solenoids in 3 sizes (Models 1000, 2000 and 3000) advance former CT line. Have



stronger seating pull without excessive a-c hum, larger contact area between co-acting parts.—*Dormeyer Industries, Dept. MA-2*, 3418 *N. Milwaukee Ave., Chicago* 41, *Ill.*

CIRCLE 215 ON READER-SERVICE CARD

SATELLITE RECEIVER

New 6.3" dia x 1.13", 1.5-lb Command Receiver receives radio instructions from ground stations to actuate

satellite's electronic equipment. Separate decoder unit is mounted with receiver, accepts 7 separate radio commands. System withstands high vibration and shock, operates in multisignal environments.—*Electronics & Ordnance Div., Avco Corp., Cincinnati* 15, *Ohio.*

CIRCLE 216 ON READER-SERVICE CARD

EVEN FOR DEWPOINTS BELOW −100° F...

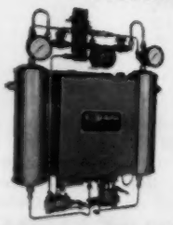
...YOU CAN RELY ON TRINITY

Super-Dry AIR SYSTEMS

Extreme reliability that complex military systems **must have,** has been engineered into TRINITY's rugged Unitized Dry Air Systems. The hundreds of systems now in service prove it. Applications include pressurizing wave guides, coax & heliax cable; purging communications and fuel lines. That's why the special knowledge of TRINITY Engineers has been called on to produce low dewpoint air systems for missiles and other military programs.

Only Unitized Dry Air Systems are available with TRINITY's **proven** Heat-Les Dryers to assure continuous, economical dry air supply. Completely self-contained, ready-to-operate systems, including compressor, dryer, accumulator, instrumentation and necessary manifolding, are available in all capacity ranges.

...AND TRINITY Heat-Les DRYERS



Dynamic desiccant dryers providing dewpoints below −100°F. No bothersome, expensive heaters. Completely automatic. Available in a wide range of capacities. Install with compressor, or air supply of your choice.

WRITE FOR COMPLETE DETAILS ON DRYERS AND SYSTEMS...

TRINITY World leader in dry gas/air systems

Heat-Les Dryers • Heat-reactivated Dryers
Thermocouples and Thermowells

TRINITY EQUIPMENT CORPORATION, CORTLAND, NEW YORK

CIRCLE 93 ON READER-SERVICE CARD

New! Motor-Tach 1/3 Shorter Than Models You're Now Using

Now you can design instrument packages that are *more compact* than ever before!

CEDAR ENGINEERING has created for you a new line of precision miniature servo motors and motor-tachometers that are *shorter, lighter, and electrically more efficient* than ever before possible.

The new short CEDAR Size 10 motor-tach, for example, is only 1.375" long . . . a full *third shorter* than conventional Size 10's and even shorter than commonly used Size 8's.

In addition to permitting more compact instrumentation, the shorter length and reduced weight minimize susceptibility to vibration failure.

Efficiency? You get normal motor output at a *lower* wattage input. And these rugged new space misers are built without compromising reliability. They fully meet requirements of MIL-E-5272C.

Specifications are now available for the new CEDAR short servo motors and motor-tachs in Sizes 8, 10 and 11. For more information, contact us *today* at the address below. We're standing by to give you immediate service.

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Division of
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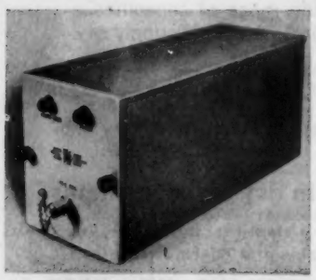
Minneapolis 16, Minnesota

CIRCLE 94 ON READER-SERVICE CARD

FREQUENCY STANDARD

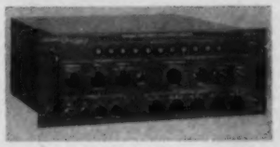


New Model S-1159 Packaged Frequency Source has rated frequency of 1-Mc with stability (short term) of one part in one billion; combines precision crystal oscillator, proportionally controlled oven and transistorized circuitry. Measures 11.5" x 4.2" x 5"; weighs 5.5 lb. Characteristics: aging, 1 part in 10^9 per day; stabilization time required for aging rate, 72 hrs; warm-up time, 4 hr; frequency adjustment range, ±3 parts in 10^6; output, 50-mv sine wave.—*Reeves-Hoffman Div., Dynamics Corp. of America, Carlisle, Pa.*

CIRCLE 350 ON READER-SERVICE CARD

FREQUENCY CALIBRATOR

New simultaneous 11-point Telemetering Frequency Calibrator, Model TMC-411E, features all-electronic

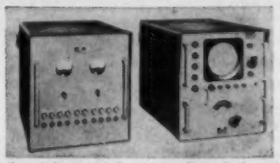


operation and 0.002% frequency accuracy. Deviation stepping from +7½% to −7½%, dwell times adjustable from ¼ to 4 sec; continuous, programmed or manual random selection. Bulletin 411E.—*Panoramic Radio Products, Inc., 520 S. Fulton Ave., Mount Vernon, N. Y.*

CIRCLE 217 ON READER-SERVICE CARD

EHF SPECTRUM ANALYZER

New Model DA-70 Spectrum Analyzer covers frequency range between 50,000 and 100,000 mc in 3

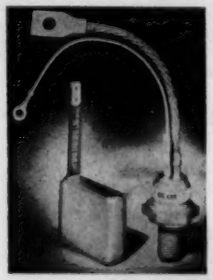


bands: 50 to 62 kmc in Band C, 60 to 80 kmc in Band B, and 75 to 100 kmc in Band A, all contained in one tuning head. Wide band display of up to 1,000 mc can be used to observe pulsated signal as narrow as 0.1 μsec. —*Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N. Y.*

CIRCLE 218 ON READER-SERVICE CARD

RECTIFIERS

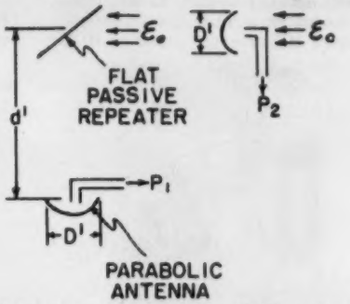
New C50 high current silicon-controlled Rectifiers (8 models) of hard-solder construction for protection



from thermal fatigue differ by repetitive peak reverse voltage ratings from 25-400 v. Average forward current rating up to 70-amp max ac, 110-amp max dc. Typical gate current required to fire is 15 mamp at 1.5 v; max voltage to fire 3.0 v. Typical turn-on time 1.0-4.5 μsec; turn-off time, 15 to 25 μsec. Brochure 170.20 9/60.—*General Electric Co., Kelley Building, Liverpool, N. Y.*

CIRCLE 219 ON READER-SERVICE CARD

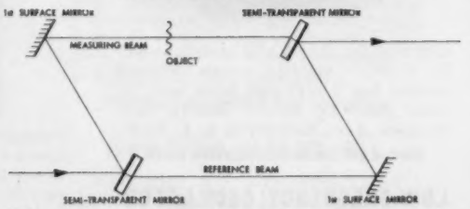
Microwave Passive Repeaters



A passive repeater . . . a flat "billboard type" reflecting surface for microwaves . . . is a highly efficient device used to re-radiate intercepted microwave energy without the introduction of additional electronic power. Microflect passive repeaters are almost 100% efficient in the reflection of the incident microwave energy . . . In a typical passive repeater application problem, the microwave engineer is faced with a situation in which the frequency of the system has been selected, the terminal stations are located, and direct communication between the terminal stations is impossible because of an intervening obstruction of some sort. The problem becomes one of selecting the most suitable site for a passive repeater, or of finding two sites for a passive repeater, or of finding two sites if a double passive repeater application is indicated . . . (*From 48-page Manual 161, Microflect Co., Inc., 3450 25th St., S. E., Salem, Ore.*)

FOR THIS LITERATURE CIRCLE 220 ON READER-SERVICE CARD

Interferometer



There are a great variety of applications where interferometry gives the best answer to problems in high speed and static photography; shock tubes and wind tunnels are now accessible in interferometric investigations in conjunction with Schlieren and Shadow methods, as well as problems in stress analysis . . . A collimated light beam, divided by a semi-transparent mirror, forms two coherent perpendicular light bundles . . . the reference beam and measuring beam. Both of them are reflected by first surface mirrors and reunited through a second semitransparent mirror. If the two path lengths are the same, and if the two bundles reunite in an almost parallel manner, interference occurs behind the second beamsplitter. If an object is placed in the measuring beam, a disturbance will be created in the interference pattern which can be used for evaluation . . .(*From 12-page brochure, Zoomar, Inc., 55 Sea Cliff Ave., Glen Cove., N. Y.*)

FOR THIS LITERATURE CIRCLE 221 ON READER-SERVICE CARD

PORTABLE CHEST CHAMBER

New Model "MC" Module Chamber with 8-cu-ft testing area operates from −100° to +750°F with accuracy

to ±5° F. Features: verticle opening front door, solid-state proportional electronic control, portable accessory base (optional).—*Statham Instruments, Inc.*, 12401 *W. Olympic Blvd., Los Angeles* 64, *Calif.*

CIRCLE 222 ON READER-SERVICE CARD

POWER SUPPLIES

Two new Microwave Power Supplies operate low and medium noise figure TW tubes. Model 252, providing all normally required electrode sources in one instrument, powers permanent magnet focused TW tubes. With solenoid supply, combination Model 252/253 operates electromagnet focused TW tubes. Model 253 includes space to mount TW tube and solenoid for local operation.—*Alfred Electronics*, 897 *Commercial St., Palo Alto, Calif.*

CIRCLE 223 ON READER-SERVICE CARD

NEW TRANSISTOR DESIGN

Microminiature silicon mesa transistor, Microbloc RT697M, with welded hermetic seal is a silicon crystal imbedded in a block that is essentially all heat sink. Meets all specs of 2N697 but with 3 watts instead of 2 watts power dissipation.—*Rheem Semiconductor Corp.*, 350 *Ellis St., Mountain View, Calif.*

CIRCLE 224 ON READER-SERVICE CARD

REFLEX KLYSTRON

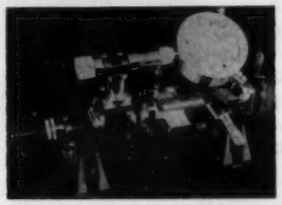
New MXX-23 electrically tunable reflex Klystron for use in X-band region is tuned in conventional mechan-

ical manner and is electrically tuned for 400 mc from any mechanical setting.—*Metcom, Inc., 76 Lafayette St., Salem, Mass.*

CIRCLE 225 ON READER-SERVICE CARD

PARAMETRIC AMPLIFIER

New S-Band Model S1000 Parametric Amplifiers offer tuning range of 100 mc, operating gain of 17 db,



bandwidth of 20 mc (at 3-db points), and system noise figure of 2.5-3.0 db (operating into mixer with noise figure of 10 db).—*Micromega Corp.*, 4134 *Del Rey Ave., Venice, Calif.*

CIRCLE 226 ON READER-SERVICE CARD

R-F POWER BRIDGE

New precision R-F power bridge Model PB-1 is designed for use with 200-ohm bolometer mounts using either 4.5 or 8.75 ma barretters or a pair of 13-ma thermistors. Accuracy of 14% in substituted power is achieved between 500 μw and 20 mw. —*Weinschel Engineering*, 10503 *Metropolitan Ave., Kensington, Md.*

CIRCLE 227 ON READER-SERVICE CARD

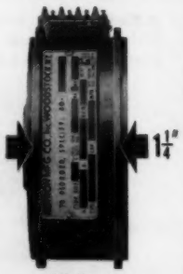
BROADBAND ISOLATOR

New 5" long, 2-lb Broadband Isolator, Model X11OLI, covers frequency range of 8.2-12.4 kmc/s.

Specs: isolation, 30 db min; insertion loss, 1.0 db max; VSWR, 1.10 max.—*E & M Laboratories, Box* 2427, *Van Nuys Sta., Van Nuys, Calif.*

CIRCLE 228 ON READER-SERVICE CARD

PROPIMAX 2®



Pat. Pend.

Air delivery of 120 cfm is obtained from a fan only 3" in diameter by 1.4" in depth and weighing only 6½ ounces. The Propimax 2 is the perfect answer for 400-cps airborne or missile applications where maximum cooling with a minimum of space and weight loss is mandatory.

Variation in driving motors includes constant speed 21,000-rpm, 11,500-rpm and Altivar® versions. The latter automatically vary their speeds directly with altitude and thereby approach constant cooling with a minimum of power drain and noise.

Simplicity of mounting is achieved by provision of "servo" type rims at either end of venturi. Airflow is reversible by turning fan end-for-end. Electrical connections made to compact terminal block. Power requirement is 400 cps, 1 or 3 phase, sinusoidal or square wave.

Write for complete technical information . . .

ROTRON

ROTRON mfg. co., inc.

WOODSTOCK • NEW YORK

In Canada: The Hoover Co., Ltd., Hamilton, Ont.

CIRCLE 95 ON READER-SERVICE CARD

mil spec issued for 2,000V top hat rectifier type 1N2361

COLUMBUS SEMICONDUCTORS® WILL SUPPLY THE IN2361 TO MEET MIL S-19500/187(SC) DATED 3/13/61

MIL S-19500/187(SC) greatly simplifies the use of the 2,000 PIV, 200 mA @ 100°C. IN2361 by military equipment manufacturers as a more reliable and space saving alternative to series strings of JAN IN540's and JAN IN547's.

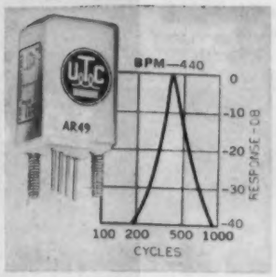
The type IN2361 is part of Columbus' group of high voltage top hat, 7/16" stud and insulated stud rectifiers covering the voltage range of 1,400-2,000 PIV with currents from 200mA to 3.5 Amps @ 100°C. This group has been supplied by Columbus for the many high voltage requirements in radar modulator circuits; in power supplies for magnetron, klystron, traveling wave and cathode ray tubes; in infra-red and atomic instrumentation and in FM and single side band transmitters. In high KV, higher current combinations, the 2,000 V types will reduce space requirements by 25% to 50% over other standard packages.

COLUMBUS ELECTRONICS CORP.

1000 SAW MILL RIVER ROAD, YONKERS, N. Y.
Tel.: YOnkers 8-1221
TWX: Yonkers, NY-1369

CIRCLE 96 ON READER-SERVICE CARD

BAND PASS FILTERS



New miniaturized (¾" x ¾" x 1⅛", 1 oz) Band Pass Filters pass frequencies of 440 to 5000 cycles, have attenuation of 35 db per octave, 2:1 gain. Input 10,000 ohms, output to grid, tapped for 10,000 ohms to provide for transistor circuits, Special filters with center frequency of 30 kc or higher available with 10,000 ohms output only.—*United Transformer Corp., 150 Varick St., New York 13, N. Y.*

CIRCLE 229 ON READER-SERVICE CARD

5-MW DIRECTIONAL COUPLER

New high power S-Band Directional Coupler, Model 45,000, handles peak power of 5.0 Mw at 15 psig. E-

plane bend incorporated in coupler is shown. Coupling is −54 db ±1 db, flat to ±1 db; directivity is 20 db min.—*Transco Products, Inc., 12210 Nebraska Ave., Los Angeles 25, Calif.*

CIRCLE 230 ON READER-SERVICE CARD

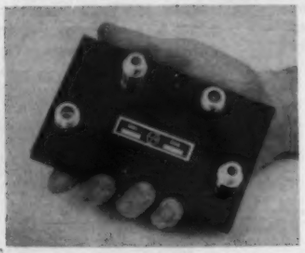
COAXIAL SWITCHES

New medium-power Coaxial Switches feature frequency and power range 6 kw CW at 30 Mc, 3

kw CW at 100 Mc, 500 w CW at 1,000 Mc; 1,000-V max RF voltage; crosstalk greater than 60 db up to 1,000 Mc; VSWR 1.1 to 1 max up to 100 Mc, 1.15 to 1 max to 1,000 Mc; models available with up to 6 positions.—*General Communications Co., 677 Beacon St., Boston 15, Mass.*

CIRCLE 231 ON READER-SERVICE CARD

MICROWAVE COMPONENTS



New Epsi-line Broadband Balanced Mixers, Directional Couplers and Multi-terminal Power Dividers reduce space normally taken up by waveguide components by 95%. Typical unit measures 5¼" x 3½" x ⅝", weighs about 1 lb.—*Instruments Div., Laboratory for Electronics, Inc., 1079 Commonwealth Ave., Boston 15, Mass.*

CIRCLE 232 ON READER-SERVICE CARD

MINI VARACTOR DIODES

Five new miniature ⅛" x ⅛" pill Varactor Diodes with cut-off frequencies through 120 kmc are for use in traveling-wave broadband parametric amplifiers at frequencies through X-band for highest cut-off types. Diodes can be supplied to ±10% capacitance tolerance. As high frequency harmonic generator, power outputs up to 20 mw are reported in tripling X-band input power to 35-kmc region.—*Microwave Associates, Inc., Burlington, Mass.*

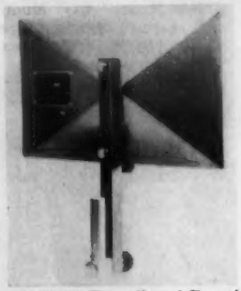
CIRCLE 233 ON READER-SERVICE CARD

TEMP-COMPENSATED ISOLATOR

New temperature-compensated ferrite Isolators in both waveguide and coaxial types are for difficult operating environments such as in aircraft and military applications. Specifications: several operating frequency bands within 1120 to 12,400 mc range, isolation up to 40 db, insertion loss of 0.5 to 1.0 db.—*Caswell Electronics Corp., 414 Queens Lane, San Jose, Calif.*

CIRCLE 234 ON READER-SERVICE CARD

UHF BROADBAND ANTENNA



New 91597-2 Broadband Bowtie Antenna for RFI measurements in 375 to 1000 mc range does not require tuning adjustments. Has sensitivity similar to tuned dipole, eliminates time required to adjust dipole lengths. Approved for use with RFI measuring instrumentation such as Stoddard NM-52A.—*Stoddard Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.*

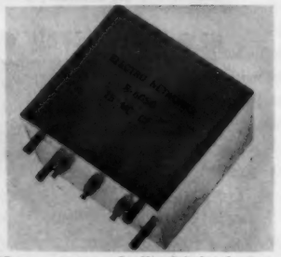
CIRCLE 351 ON READER-SERVICE CARD

INDICATOR LIGHT

New L16,200 Indicator Light (shown) has silicone rubber boot and panel sealing rib for water-tightness and reliability. Features 6, 14 or 28-v lamp, front-of-panel lamp replacement. New L20046 Indicator is rated for 60,000 hr of operation at 5 v or 6,000 hr at 6.3 v, features sealed construction, surpasses mil specs. Catalog 120.—*Control Switch Div., Controls Co. of America, Folcroft, Pa.*

CIRCLE 352 ON READER-SERVICE CARD

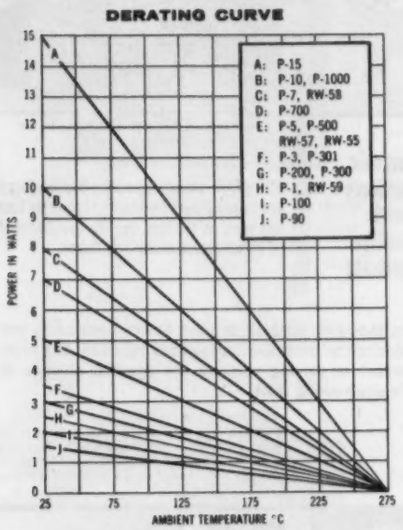
HF PASS FILTER



New custom built high frequency filter for ground and airborne IF systems with center frequency at 15 mc, 30 mc or customer-specified frequency has band width from 150 kc to 3 mc, shape factor of from 3:1 to 12:1, and is provided in any impedance desired from 73 to 10,000 ohms.—*Electro Networks, Inc., 1920 Park St., Syracuse, N. Y.*

CIRCLE 353 ON READER-SERVICE CARD

Precision Power Resistors

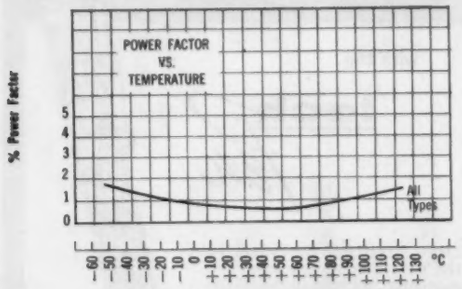


Designed for applications with critical space limitations. Mepco miniature Type P and RW power resistors permit the handling of high wattages in small packages and provide precision resistance tolerances.

The basic military specification (MIL-R-26C) provides for resistance tolerances down to only 5%. Mepco precision power resistors are available with tolerances down to 0.05% . . . (*From 24-page Catalog WC-3, Mepco, Inc., Morristown, N. J.*)

FOR THIS LITERATURE CIRCLE 235 ON READER-SERVICE CARD

Metallized Paper Capacitors



Aerovox High Temperature Metallized-Paper Capacitors are designed to meet critical operating requirements and the need for increased reliability in the electronic field . . . Temperature Range: The P123ZN 50 VDC metal cased capacitors are capable of operating over a range of —55° C to + 100 °C at full voltage rating . . . Power Factor: Power Factor when measured at or referred to a frequency of 1000 cycles per second on capacitors up to and including 1.0 mfd and when measured at or referred to a frequency of 60 cycles per second on capacitors greater than 1.0 mfd will be 1% or lower at +25° C . . . (*From 6-page Catalog 131 B8, Aerovox Corp., New Bedford, Mass.*)

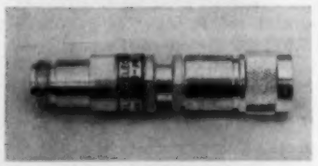
FOR THIS LITERATURE CIRCLE 236 ON READER-SERVICE CARD

WIDE-BAND COUPLERS

New directional couplers (formerly only with Type N connectors) have been redesigned to allow quick modification to types "C", BNC, TNC and LT. Available from 250 through 4000 MC, each unit covers a 2:1 frequency range; 10, 20 and 30 db couplings in any range.—*Radar Design Corp., Pickard Dr., Syracuse 11, N. Y.*

CIRCLE 237 ON READER-SERVICE CARD

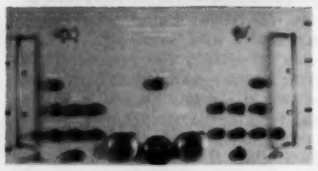
LOW-PASS FILTERS



New 100-w Model F-30 miniaturized, precision coaxial low-pass Filters are available with cut-off frequencies of 100 to 10,000 Mc and with Type N, C, or TNC connectors. Max VSWR of 1.2 and max insertion loss of 0.2 db in pass band. Stop band rejection of 60 db from 1.35 to 5 fc.—*RLC Electronics, Inc., 805 Mamaroneck Ave., Mamaroneck, N. Y.*

CIRCLE 238 ON READER-SERVICE CARD

BEACON CODE SIMULATOR



New Model PSG-10A Beacon Code Simulator double-pulsed microwave signal source covering 2.7-2.9 kmc and 5.1-5.9 kmc checks sensitivity and pulse decoding circuitry of radar beacons. Pulse width can be adjusted from 0.3-10 μsec, pulse spacing from 0-100 μsec, and PRF from 10-2000pps. —*Micro-Tel Corp., 2127 Maryland Ave., Baltimore 18, Md.*

CIRCLE 239 ON READER-SERVICE CARD

HI-TEMP SOLENOID

New hermetically sealed actuator with plunger travel of 0.020" has life rating of 1000 hrs at 1000° F and withstands temperatures to 1600°F. Available with both rigid and flexible conduit.—*Barber-Colman Co., Aircraft & Missiles Products Div., Rockford, Ill.*

CIRCLE 240 ON READER-SERVICE CARD

Automatic projection head for the Haloid-Xerox Copyflo® continuous printer . . . one of many devices designed and made by Wollensak for a number of major companies.
3" f/1.9 Oscillo Raptar (6 element) lens . . . 1:0.9 reduction . . . mounted in No. 3 Alphax heavy duty synch shutter . . . representative of many lens-shutter combinations where performance is the only criteria.
WF-8A FASTAX 35mm full frame metric high speed motion picture camera and 27 other models . . . the perfect tool for design and development engineers.
Wollensak 20-60mm f/1.8 Vari-Focus Zoom lens for 16mm motion picture cameras . . . and others both manual and powered . . . for a variety of professional and industrial applications.
Project oriented Mirrotel catadioptric lens systems for radar boresighting . . . visual and photographic tracking.
Infra-Red Guidance Components for air-to-air "Sidewinder." Engineered and manufactured by Wollensak

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OPTICAL COMPANY • ROCHESTER 21, N. Y.

CIRCLE 98 ON READER-SERVICE CARD

CONTROL KNOBS

New series of control knobs for multiple purpose include skirted-type knobs with ⅜" to 1½" dia and dual concentric knob combining ¾" and 1¼" sizes. Available with molded hole or brass insert, can be supplied with indicator line on skirt and crown.—*Harry Davies Molding Co., 1428 N. Wells St., Chicago 10, Ill.*

CIRCLE 241 ON READER-SERVICE CARD

POTENTIOMETERS

New 1⅛"-dia precision potentiometers meet original specs after 2,000-hr operation at 150°C. Units have standard resistances from 100-50,000 ohms, may be obtained with conformities of 0.14% if required.—*Carter Mfg. Corp., 23 Washington St., Hudson, Mass.*

CIRCLE 242 ON READER-SERVICE CARD

IMMERSION GOLD

Technic's OROMERSE

A neutral Immersion Gold for the production of 24Kt gold plates up to 10 millionths direct on copper, brass, nickel, iron, lead, and solder plates

Technic inc

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Providence, 1 R.I.
Plants: Cranston, R. I.
STuart 1-6100

Chicago Office: 7001 No. Clark St.

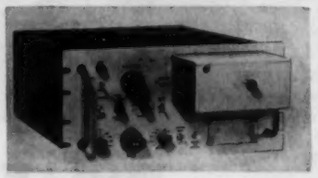
CIRCLE 99 ON READER-SERVICE CARD

POWER RESISTOR

New 5-w Type RH-5 wire-wound, precision Power Resistor meets power and heat dissipation problems complicated by miniaturization. Sealed in silicone and inserted in finned aluminum housing, unit meets mil-spec, is impervious to moisture, is 0.600" x 0.334". Has 0.5 ohm-20K ohm resistance range, 0.05%—3% tolerance range, 0.00002/°C temp coefficient. Bulletin R-21.—*Dale Products, Inc., Columbus, Neb.*

CIRCLE 243 ON READER-SERVICE CARD

LF PANORAMIC RECEIVER



New An/URM-126 low frequency panoramic field intensity Receiver continuously monitors LF radiation from 0.05 to 100 kc, operates unattended, and automatically produces panoramic photographic records. Applications include precision measurement, display and recording of intensities of noise and both modulated and unmodulated CW signals.—*Military Electronics, Div., Motorola Inc., 8201 E. McDowell Rd., Scottsdale, Ariz.*

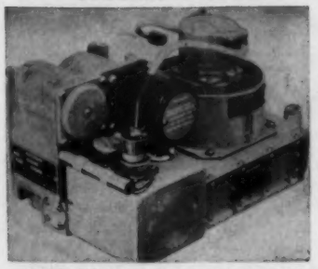
CIRCLE 244 ON READER-SERVICE CARD

LIQUID FILTER

New lightweight full-flow filter features efficient filtration. The 20-micron unit is fitted with a by-pass relief valve that is activated by a two-pound rise in differential pressure. Housing encloses miniature "stack" of circular wire cloth filter elements assembled on keyed spindle.—*Screen Products, Inc., Caldwell, N. J.*

CIRCLE 245 ON READER-SERVICE CARD

COOLING SYSTEM



New Liquid Cooling System E/HT-250, Type 200 A, for airborne ECM systems consists of hydraulic coolant pack E/HS-500, Type 100A, and constant-mass blower-radiator assembly; can be mounted as shown or in separate locations. System weighs 17 lb, measures 8¼" x 7" x 13¾", features 2000-w capacity, provides Coolanol 45 at max of 185°F delivered at 1 gpm and 55 psig system discharge pressure. Requires 115/208 v, 400 cycle, 3 phase and 28-v dc for control purposes.—*Eastern Industries, Inc., 100 Skiff St., Hamden, Conn.*

CIRCLE 246 ON READER-SERVICE CARD

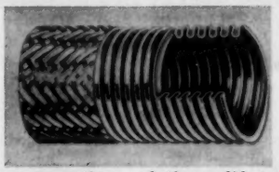
4PDT RELAY

New 4B Series Relay features pin arrangement and small size (0.800" x 0.800" x 0.875") for printed circuit boards. Better sensitivity per pole than two 2PDT miniature relays; optional terminal arrangement of long or short leads or hook terminals. —*Hi-G, Inc., Bradley Field, Windsor Locks, Conn.*

CIRCLE 247 ON READER-SERVICE CARD

METAL HOSE

New Hi-Flex ¼" to 1¼" helically convoluted, braided or unbraided Metal Hose line offers improved flexibility,



pressure ratings, fatigue life and ease of cleaning. Suggested working pressure in ¼"-size is as high as 4500 psi, static bend radius is 1.03". —*Flexonics Corp., 1315 S. 3 Ave. Maywood, Ill.*

CIRCLE 248 ON READER-SERVICE CARD

Super Power Hydrogen Thyratron Test Set

Dynamic solutions with creative ingenuity

FXR's high power electronics has produced the Super-Power Hydrogen Thyratron Test Set used as the tool for the development of super-power modulator tubes.

FXR's top-rated position in High Power Electronics can be credited to extensive, specialized facilities. But most important in serving you are the creative abilities of FXR's engineering staff.

Perhaps a modulator problem similar to your own has already been solved by our technical group. An experienced FXR applications engineer is just a phone call away.

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CIRCLE 100 ON READER-SERVICE CARD

EXPERIMENTAL PRINTED CIRCUITS

as easy as drawing a line

with the **tech Pen**

Draw directly on the copper with the Tech-Pen, let dry a few moments and then immerse in your regular etch solution.

The etch resistant Tech-Pen ink will protect the copper it covers.

Just wipe off the ink with a solvent such as xylol, toluol, carbon tet . . . and you have your printed circuit.

The Tech-Pen is also ideal for marking all laboratory apparatus. Writes easily on glass, ceramics, plastics and all metals.

Ink colors: red, yellow, green, blue, orange, pink, purple, brown, aluminum, black, white.

4.50

includes supply of ink

Refills: 75¢ per tube

Mark-Tex Corp., 161 Coolidge St., Englewood, N.J.

CIRCLE 101 ON READER-SERVICE CARD

THIN-FILM RESISTORS

New line of thin-film carbon resistors offer excellent high frequency characteristics and stability under pulse applications. Pyrolytically deposited films on selected substrates are protected with special epoxy resins. Thin films and lack of spiralling result in minimum inductances.—*Film Resistors Inc., 242 Ridgedale, Ave., Morristown, N. J.*

CIRCLE 249 ON READER-SERVICE CARD

EPOXY BUSHING

New Model M-1003 hermetic-seal feed-through bushings are constructed of solid cast-epoxy resin. Capable of corona-free operation at 40 kv and has a peak pulse operating level of greater than 70 kv for air-to-oil (or 140 kv oil-to-oil).—*Components for Research Inc., 979 Commercial St., Palo Alto, Calif.*

CIRCLE 250 ON READER-SERVICE CARD

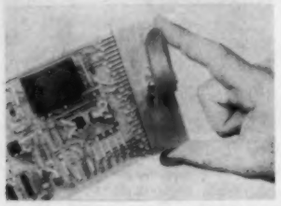
RELAY SWITCH

New Model 700 Thermal Time Delay Relay Switch is linear expansion type miniature compensated for operation from −65° to +125°C; withstands 50 G's and vibration levels of 55-500 cps. Wiping action of moving contact lengthens life, lowers contact resistance. Contact arrangement is SPST normally open or normally closed, 3-amp, 115-v ac resistive.—*Thermal Controls, Inc., 41 River Rd., North Arlington, N. J.*

CIRCLE 251 ON READER-SERVICE CARD

SOLDER MASK

New Quick-Clip Solder Mask fits snugly over etched contacts on printed-circuit board which are in-



serted into connector. Teflon coating prevents contamination and eliminates solder buildup on mask.—*Western Electronics Products Co., 2420 N. Lake Ave., Altadena, Calif.*

CIRCLE 252 ON READER-SERVICE CARD

PULSED X-RAY SYSTEM

New Model 5660 pulsed X-ray System makes cineradiographs of high-speed phenomena in 1 μsec or less.

X-ray generating console (left) includes 20-Mw pulse generator, which requires 2500-w, 110-v ac, 60-cps power. Intensifier console (right) requires 400 w at 110-v ac, 60 cps.—*Zenith Radio Corp., 6001 W. Dickens, Chicago 39, Ill.*

CIRCLE 253 ON READER-SERVICE CARD

SOLENOID VALVE

New miniature (0.3 lb, 2 3/4 " x 1 3/32" dia) Solenoid Valve for aircraft and missiles is available as two-way, normally closed valve or as three-way valve. Three-way asembly, by reversing ports, can be three-way, normally open valve; three-way, normally closed valve; or selector valve. Flow capacity equal to 1/8" dia sharp-edged orifice; service pressure, 0 to 3000 psi; temp range, −65° to +165°F; voltage, 18 to 30-v dc.—*Kidde Aero-Space Div., Walter Kidde & Co., Inc., Belleville 9, N. J.*

CIRCLE 254 ON READER-SERVICE CARD

THE IDEAL SCOPE FOR ALL INVESTIGATIONS FROM DC TO 5 MC

FOR EXTENDED GENERAL PURPOSE APPLICATIONS

DU MONT 440

5 MC OSCILLOSCOPE

- DC to 5 MC bandwidth in vertical amplifier.
- Sensitivity from 50 mv/cm to 500 volts full scale.
- Sweep speeds continuous from 0.2 usec/cm to 10 sec full scale.
- Rise time 0.08 usec or less.
- Selection of auto, driven or single sweep.
- Balanced input on all ranges.
- 500 kc bandwidth on horizontal axis.

When "general-purpose" applications include frequencies approaching 5 MC, the new Du Mont 440 is the all-around answer. A relatively low-cost scope of superlative performance and dependability, the 440 offers a host of operational advantages extending the value and precision of the instrument. Such advantages include: 17 sweep speeds, accurately calibrated from 1 usec/cm to 200 milliseconds to lock in any recurring phenomena within this range; accelerating potential of 5 kv for extra-bright displays; a sweep arming feature for triggering of a single sweep; A sweep expander; a ten-step attenuator for any signal from 50 mv/cm to 500 volts full scale.

The Du Mont 440 oscilloscope is the new standard for extended general-purpose applications, and costs only **$595**

(440R, RACK MOUNTED $595)

DU MONT

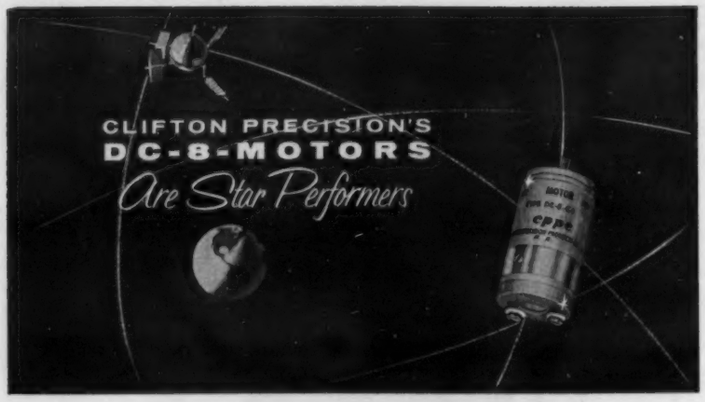
WRITE FOR COMPLETE DETAILS, OR ASK FOR A DEMONSTRATION. THESE UNITS ARE AVAILABLE NOW!

ALLEN B. DU MONT LABORATORIES, Clifton, N. J.

FAIRCHILD CAMERA AND INSTRUMENT

DIVISIONS OF

CIRCLE 102 ON READER-SERVICE CARD



500 HOUR LIFE GUARANTEE*

Due largely to improved brush design, CPPC size 8 DC motors qualify to catalogue specification after 500 + hours of continuous duty or 200,000 cycles of intermittent duty in controlled environments.

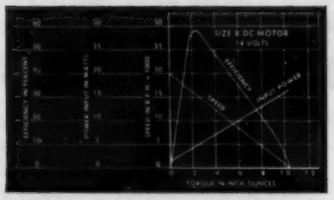
PRECISION CONSTRUCTION

Featuring a 12-bar commutator (5/16" dia.), stainless steel ball bearings, and corrosion resistant materials, the DC-8 family of motors is designed for miniature instrument systems. Weight 40 gms., length 1.380" max., dia., .750".

OUTSTANDING EFFICIENCY

The typical performance curves (below) exhibit a linear torque-speed characteristic. The efficiency—up to 60% at .25 in. oz. torque—considerably surpasses that of other types of Servomotors.

*without overhaul



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CLIFTON HEIGHTS, PA.

ENGINEERS—Join a pioneer in the rotary components field. Write David D. Brown, Director of Personnel.

CIRCLE 103 ON READER-SERVICE CARD

BEAM
COMPASS
SOLVES Your CIRCLE PROBLEMS
SAVE
TIME and
MONEY
Beam lengths from 7" to 78½" one piece anodized aluminum. Coursers available in Aluminum, Nylon, or attractive Plastic. Sets available, individually priced from $3.45 or made up to individual requirements. (15% quantity discount on 3 or more sets)
NON-SLIP "GRIP-RINGS" furnished with all points.
Send for Circular and Price List Today
FERANCE Construction Co.
28 Woodside Drive • Penfield, N. Y.

CIRCLE 104 ON READER-SERVICE CARD

THE OPTICAL TESTER
for testing lenses and mirrors

Determines focal length, abberations, and accuracy of optical figure.

Send for Bulletin 59

Ann Arbor Optical Co.
P. O. Box 1091
Ann Arbor, Mich.

CIRCLE 105 ON READER-SERVICE CARD

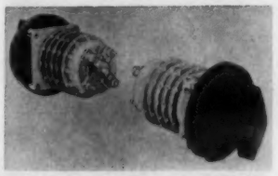
For Additional Information on Products Listed Circle Inquiry Card and Mail

CERAMIC POWER TRIODE

New D-1008 ceramic-metal Power Triod is water-cooled tube, featuring heavy wall copper anode and mesh type cathode. Tube rated at 60-kw full power input to 50 mc and reduced input to 110 Mc with max anode dissipation rated at 20 kw. As hard-tube radar modulator, D-1008 switches 220 amp at voltages up to 18 kv at rated cathode voltage.—*ITT Components Div., Electron Tube Div., Box* 412, *Clifton, N. J.*

CIRCLE 255 ON READER-SERVICE CARD

TYPE JM ROTARY SWITCH



New Type JM Rotary Switch with wholly enclosed contact mechanism controls up to 75 poles with single knob. Complies with BuShips drawings and Mil specs. Bulletin 22.—*Electro Switch Corp., King Ave., Weymouth* (*Boston* 88), *Mass.*

CIRCLE 256 ON READER-SERVICE CARD

OSCILLOGRAPH AMPLIFIER

New low-cost oscillograph amplifier Model T249 has two independent amplifier channels, a common power supply, and zeroing and sensitivity adjustments on each channel. Input impedance is 100 kilohm and frequency response is dc to 10 kc. Maximum output is 8 milliamps and maximum sensitivity is 2 ma/v.—*Avtron Mfg. Inc.*, 10409 *Meech Ave., Cleveland*, 5, *Ohio.*

CIRCLE 257 ON READER-SERVICE CARD

Precision Temperature Controllers

Do You need .001°C control in the range of −200°C to +500°C?

Also offered: Constant temperature baths with mechanical refrigeration

Literature Available

BAYLEY INSTRUMENT CO.

Box 538 **Danville, Calif.**

CIRCLE 106 ON READER-SERVICE CARD

VINYL-GRIP HANDLES

New aluminum handles have grey or black vinyl-dip finish. Handle keeper, with mounting holes for rivets or

blank for spotwelding, attaches without handle, allows "paint-bake" process without discoloring handles.—*TA Mfg. Corp.*, 4607 *Alger St., Los Angeles* 39, *Calif.*

CIRCLE 258 ON READER-SERVICE CARD

PORTABLE TEMPERATURE CHAMBER

New Hot-Cold portable temperature chamber is heated by electricity and cooled by either liquid CO_2 or dry ice, is regulated to any temperature in the −100°F to 500°F to within ±½°F. Can be programmed by auxiliary timer to alternate between high and low temperatures.—*Delta Design, Inc.*, 7460 *Girard Ave., La Jolla, Calif.*

CIRCLE 259 ON READER-SERVICE CARD

BOOK REVIEWS

PRINCIPLES OF SEMICONDUCTOR DEVICE OPERATION, by A. K. Jonscher, (1960) John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 168p., 6" x 9", $5.00. Transport laws for excess carriers, a complete theory of junction diodes, and carrier transport in inhomogenous media are fully discussed.

CIRCLE 260 ON READER-SERVICE CARD

DIRECT CONVERSION OF HEAT TO ELECTRICITY, by Joseph Kaye and John A. Welsh, editors, (1960) Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 353 p. 6" x 9", $8.75. Edited collection of 23 papers cover thermoelectric, thermionic, magnetohydronamic and fuel cell types of conversion.

CIRCLE 261 ON READER-SERVICE CARD

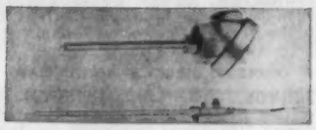
ELECTRONIC MAINTAINABILITY, Vol. 3, edited by Maj-Gen F. L. Ankenbrandt, USAF (1960), Engineering Publishers, P.O. Box 2, Elizabeth, N. J. 312 p. 6" x 9", $10.00. Twenty-eight papers discuss aspects of maintainability from military, systems design and training standpoints.

CIRCLE 262 ON READER-SERVICE CARD

ELECTRONICS IN ENGINEERING, by W. Ryland Hill, Second Edition, (1961), McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y., 340 p., 6" x 9", $8.00. New edition of standard text includes new semiconductors with circuit analysis for tubes integrated with that for transistors.

CIRCLE 263 ON READER-SERVICE CARD

HI-TEMPERATURE SENSORS



New line of thermocouple-type Temperature Sensors for use up to 4000°F of the non-cooled and cooled types to measure liquid, solid, and gaseous temperatures, uses refractory metals, i.e., tantalum and molybdenum with special CR oxidation-resistant coatings. Insulation is magnesia and beryllia and thermocouple wires are iridium, tungsten, rhenium, and alloys of these elements.—*Aero Research Instr. Co., Inc.*, 315 *N. Aberdeen St., Chicago 7, Ill.*

CIRCLE 264 ON READER-SERVICE CARD

SUBCARRIER OSCILLATOR

New Model 0-20 voltage-controlled subcarrier oscillator features excellent data stability for FM telemetering applications ranging from −55°C to 125°C. Available in all standard IRIG channels with inputs of either 0 to 5 v, or −2½ v to +2½ v.—*Dorsett Electronics Laboratories, Inc.*, 119 *W. Boyd, Norman, Okla.*

CIRCLE 265 ON READER-SERVICE CARD

SERVOVALVE

New servovalve using jet-pipe principle performs at contamination levels 25 times greater than previously possible, assuring positive automatic control in all airborne or ground electro-fluid and gas systems without contamination control measures.—*Raymond Atchley, Inc.*, 2339 *Cotner Ave., Los Angeles, Calif.*

CIRCLE 266 ON READER-SERVICE CARD

SUBMINIATURE RELAY

New subminiature series V relay meets severe environmental requirements. Has improved bounce characteristics which increase contact life and reliability. Available with or without arc-inhibiting circuits and with either ac or dc relay motors.—*Filtors, Inc., Port Washington, N. Y.*

CIRCLE 267 ON READER-SERVICE CARD

GEAR MOTOR

Fractional hp gear motor uses unique rectangular field stack for high efficiency in small package size. Up to ¼ hp from 1¼ lbs weight is also aided by special heat dissipating technique.—*Electro-Mechanical Div., Bendix-Pacific*, 11600 *Sherman Way, North Hollywood, Calif.*

CIRCLE 268 ON READER-SERVICE CARD

LINE PROGRAMMING RACK

New Model 254 rack can cross-patch and/or terminate 2360 coaxial signal lines for data handling. Rapid programming uses color-coded panel and taper pin connectors. Meets Mil-specs with negligible crosstalk.—*E D P Corporation*, 3501 *S. Orange Blossom Trail, Orlando, Fla.*

CIRCLE 269 ON READER-SERVICE CARD

RESONANT CIRCUIT

New Model BF-128, 45-kc Resonant Circuit, amplifies by using resonance effect to increase voltage level of signal of resonant frequency while rejecting other frequencies. Used in triggering and timing circuits. Maximum 3-db bandwidth of 4500 cps and source impedance of 3000 ohms; ⅞" x 1⅛" x 1".—*Control Electronics Co., Inc., Filter Div.*, 10 *Stepar Place, Huntington Sta., L. I., N. Y.*

CIRCLE 270 ON READER-SERVICE CARD

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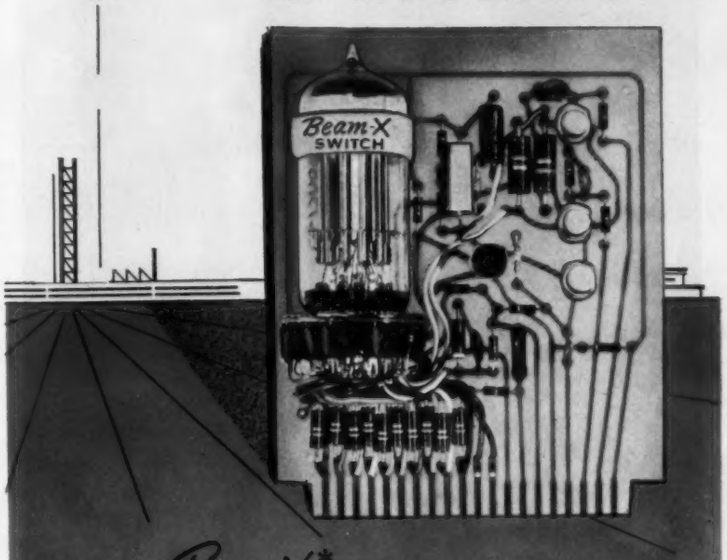

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Plainfield, New Jersey

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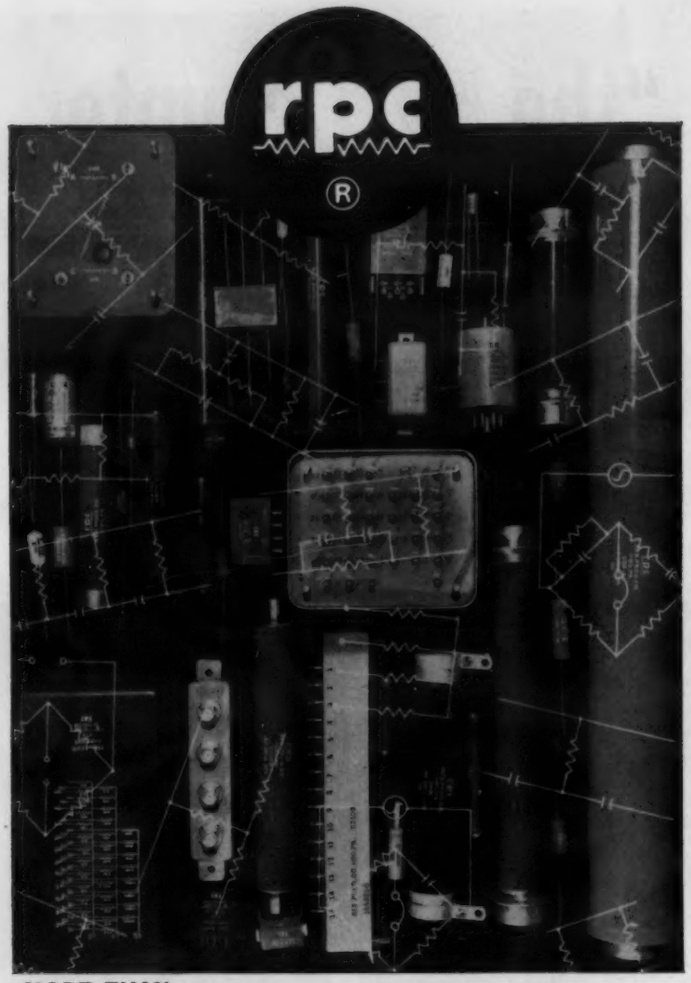

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CIRCLE 108 ON READER-SERVICE CARD

MSD new literature

RELAYS. 6-page Bulletin AV2022 describes Syncroverter High-Speed Relays.—Bristol Co., Bristol Rd., Waterbury 20, Conn.
CIRCLE 271 ON READER-SERVICE CARD

PRESSURE WINDOWS. 2-page Bulletin WD-60 describes waveguide pressure windows.—Microwave Development Labs., Inc., 92 Broad St., Babson Park 57, Wellesley, Mass.
CIRCLE 272 ON READER-SERVICE CARD

ELECTRICAL TAPES. 4-page property chart covers reference data for Scotch brand electrical tapes.—Dept. WO-482, Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.
CIRCLE 273 ON READER-SERVICE CARD

WIRE. 4-page brochure outlines factors involved in maintaining properties of metals and alloys to achieve reproducibility.—Secon Metals Corp., 7 Intervale St., White Plains, N. Y.
CIRCLE 274 ON READER-SERVICE CARD

WIRE. 4-page bulletin describes Manganin Shunt Grade Wire.—Molecu Wire Corp., Eatontown-Freehold Pike, Scobeyville, N. J.
CIRCLE 275 ON READER-SERVICE CARD

WIRE. 12-page brochure gives condensed data on electronic hook-up wire.—Sequoia Wire & Cable Co., Subs. Anaconda Wire & Cable Co., 2201 Bay Rd., Redwood City, Calif.
CIRCLE 276 ON READER-SERVICE CARD

CIRCUIT BOARDS. 4-page brochure presents data on Teflon-glass copper-clad printed circuit board.—General Plastics Corp., 55 La France Ave., Bloomfield, N. J.
CIRCLE 277 ON READER-SERVICE CARD

CONNECTORS. 44-page Catalog 20-1060 describes miniature rectangular plug-and-socket connectors.—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.
CIRCLE 278 ON READER-SERVICE CARD

HIGH-TEMP PRODUCTS. 4-page brochure describes Teflon extruded tubing, insulated lead wire and cable, silicone-rubber coated fiberglass sleeving, etc.—L. Frank Markel & Sons, Norristown, Pa.
CIRCLE 279 ON READER-SERVICE CARD

SEMICONDUCTOR BASES. 4-page Bulletin 2714 describes stud-mounted semi-conductor bases and mating caps.—Standard Pressed Steel Co., Box 592, Jenkintown, Pa.
CIRCLE 280 ON READER-SERVICE CARD

BLACK GLASS. 8-page brochure details special black glass for encapsulating diodes.—Corning Glass Works, Receiver Bulb Sales Dept., Corning, N. Y.
CIRCLE 281 ON READER-SERVICE CARD

DRY LUBRICANT. 4-page brochure details use of Hi-T-Lube, high-temp dry lubricant.—General Magnaplate Corp., 331 Main St., Belleville, N. J.
CIRCLE 282 ON READER-SERVICE CARD

INDICATOR. 2-page Catalog Sheet 9813-06 details 3-in-1 Bearing-Distance-Heading-Indicator.—John Oster Mfg. Co., Avionic Div., Racine, Wis.
CIRCLE 283 ON READER-SERVICE CARD

SERVOS. 4-page Catalog SFC-1 describes Series 200 Vacuum Tube and Series 500 all-solid state Servo Indicators and Repeaters.—North Atlantic Industries, Inc., Terminal Dr., Plainview, L. I., N. Y.
CIRCLE 284 ON READER-SERVICE CARD

POTS. RESISTORS. 8-page Military Components Catalog details stock items.—Clarostat Mfg. Co., Inc., Dover, N. H.
CIRCLE 285 ON READER-SERVICE CARD

ACCELEROMETER. 2-page bulletin details static-response, natural quartz crystal accelerometer.—Kistler Instrument Corp., 15 Webster St., N. Tonawanda, N. Y.
CIRCLE 286 ON READER-SERVICE CARD

COUNTERS. 2-page data sheet describes Series 1736 precision internal pinion counters.—Veeder-Root Inc., 70 Sargeant St., Hartford 2, Conn.
CIRCLE 287 ON READER-SERVICE CARD

COUNTER-TIMERS. 4-page bulletin details 10-Mc solid-state Counter-Timers.—Transistor Specialties, Inc., Terminal Dr., Plainview, N. Y.
CIRCLE 288 ON READER-SERVICE CARD

TELEMETERY RECEIVER. 2-page Data Sheet C-002 describes 30-260 Mc Type 1907 Telemetry Receivers.—Vitro Electronics, Div. Vitro Corp. of America, 919 Jesup-Blair Dr., Silver Spring, Md.
CIRCLE 289 ON READER-SERVICE CARD

DATA CONVERTER. 2-page Product Spec DPS/A53 describes CV-772 radiosonde balloon Data Converter.—Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.
CIRCLE 290 ON READER-SERVICE CARD

TRANSISTOR SORTER. 2-page Bulletin 1 describes solid-state, modular Automatic Transistor Sorter.—Monitor Systems, Inc., Subs. Epsco, Inc., Fort Washington Industrial Park, Fort Washington, Pa.
CIRCLE 291 ON READER-SERVICE CARD

READER/PROGRAMMER. 2-page Bulletin 106 describes Model CR-P8-BMD Time Code Reader/Programmer.—Computer Equipment Corp., 11612 W. Olympic Blvd., Los Angeles 64, Calif.
CIRCLE 292 ON READER-SERVICE CARD

COMPUTER ELEMENTS. 24-page catalog describes transistorized computer elements employing printed circuitry and modular construction.—Ransom Research, 374 W. 8 St., San Pedro, Calif.
CIRCLE 293 ON READER-SERVICE CARD

AVIATION ELECTRONICS. 44-page catalog describes airborne and ground communication and navigation equipment.—Wilcox Electric Co., Inc., 1400 Chestnut St., Kansas City 27, Mo.
CIRCLE 294 ON READER-SERVICE CARD

DIGITAL RESOLVER. 2-page Bulletin W302 presents Digital Resolver Model DR-14.—Computer Control Co., Inc., 2251 Barry Ave., Los Angeles 64, Calif.
CIRCLE 295 ON READER-SERVICE CARD

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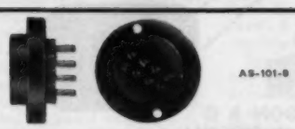

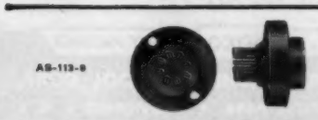

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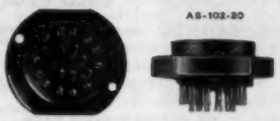

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AIR FILTERS. 8-page Bulletin B100-6 contains data necessary to size and specify air filters for electronic equipment.—Farr Co., Box 90187, Airport Sta., Los Angeles 45, Calif.

CIRCLE 296 ON READER-SERVICE CARD

ELECTRONIC INSTRUMENTS. 4-page catalog describes voltage sources, dc-to dc converters, dc-to-ac inverters, etc.—Electronic Development Corp., 423 West Broadway, Boston, Mass.

CIRCLE 297 ON READER-SERVICE CARD

MICROCIRCUITRY. 2-page data sheet contains performance data on materials used in "thin film integrated circuitry."—Halex, Inc., Box 546, El Segundo, Calif.

CIRCLE 298 ON READER-SERVICE CARD

INLAID CIRCUITS. 4-page brochure describes Precision Flush Circuits.—Scientific Components, Inc., 30 S. Salsipuedes St., Santa Barbara, Calif.

CIRCLE 299 ON READER-SERVICE CARD

ELECTRONIC EQUIPMENT. 16-page catalog describes d-c power supplies and test instruments.—Opad Electric Co., 43 Walker St., New York 13, N. Y.

CIRCLE 300 ON READER-SERVICE CARD

SYNCHRO AND RESOLVER MANUAL consists of 27 pages of illustrated technical information.—Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J.

CIRCLE 301 ON READER-SERVICE CARD

CAPACITORS. 6-page Catalog 131B8 describes high-temp metallized paper capacitors.—Aerovox Corp., New Bedford, Mass.

CIRCLE 302 ON READER-SERVICE CARD

RESISTORS. 2-page Bulletin P-3-7/60 describes encapsulated printed-circuit type resistors.—Reon Resistor Corp., 155 Saw Mill River Rd., Yonkers, N. Y.

CIRCLE 303 ON READER-SERVICE CARD

DIODES. 4-page catalog details high parameter "Cool Junction" diodes.—Delta Semiconductors, Inc., 835 Production Place, Newport Beach, Calif.

CIRCLE 304 ON READER-SERVICE CARD

DIODES. 6-page catalog gives electrical specs of 4-layer diodes.—Shockley Transistor Unit, Clevite Transistor, Stanford Industrial Park, Palo Alto, Calif.

CIRCLE 305 ON READER-SERVICE CARD

TRANSFORMER KIT. 2-page catalog sheet describes how Model C-2650 kit can be used to determine production requirements in micro-miniature transistor circuits.—James Electronics Inc., 4050 N. Rochwell St., Chicago 18, Ill.

CIRCLE 306 ON READER-SERVICE CARD

TELEMETRY SWITCH. 6-page Bulletin 10 S describes microminiature 450-circuit Telemetry Switch.—Electro-Tec Corp., 10 Romanelli Ave., S. Hackensack, N. J.

CIRCLE 307 ON READER-SERVICE CARD

CHECK-OUT SYSTEM. 8-page bulletin describes Speed-Tronik "all-parameter" automatic testing system.—Audiotronics Co., Box 2187, Dayton, 29, Ohio.

CIRCLE 308 ON READER-SERVICE CARD

TEST CHAMBER. 4-page bulletin details operative principle and features of MC Temp Test Chamber.—Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

CIRCLE 309 ON READER-SERVICE CARD

ATTENUATORS. 4-page Bulletin 500 describes microwave waveguide and coaxial attenuators.—PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y.

CIRCLE 310 ON READER-SERVICE CARD

THERMOELECTRIC DEVICES are described in 2-page reprint.—Materials Electronic Products Corp., 990 Spruce St., Trenton 8, N. J.

CIRCLE 311 ON READER-SERVICE CARD

TRANSDUCER SYSTEMS. 42-page Bulletin TD-105 presents applications of high accuracy transducer systems.—Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.

CIRCLE 312 ON READER-SERVICE CARD

MECHANICAL ARMS. 20-page booklet describes manipulator-equipped vehicle systems for remote handling operations.—Nuclear Equipment Dept., General Mills, 419 N. 5 St., Minneapolis 1, Minn.

CIRCLE 313 ON READER-SERVICE CARD

SCANNERS. 2-page Bulletin 27096 describes Scanner Unit and Time Code Generator.—Electronic Engineering Co. of Calif., 1601 E. Chestnut Ave., Santa Ana, Calif.

CIRCLE 314 ON READER-SERVICE CARD

TRANSISTOR AMPLIFIER. 2-page Bulletin 42-870 details 0.531"-dia 4-stage Transistor Amplifier.—Centralab, Div. Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

CIRCLE 315 ON READER-SERVICE CARD

COMPONENTS. 36-page catalog details phono jacks; interlock, phono and speaker plugs; turret terminals and boards, etc.—Accurate Electronics Corp., 169 S. Abbe Rd., Elyria, Ohio.

CIRCLE 316 ON READER-SERVICE CARD

ELECTRONIC COMPONENTS. Folder contains collection of data sheets on Wave Filters, Toroidal Coils, Magnetic Amplifiers.—Components Corp., 2855-57 N. Halsted St., Chicago 14, Ill.

CIRCLE 317 ON READER-SERVICE CARD

MOTORS. 8-page brochure describes special motor design facilities and capabilities.—Kollsman Motor Corp., Mill St., Dublin, Pa.

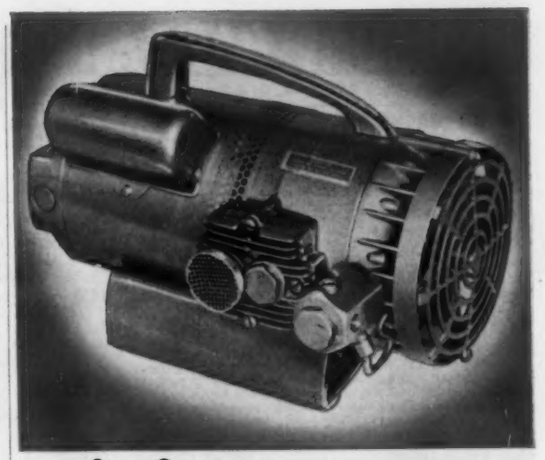
CIRCLE 318 ON READER-SERVICE CARD

SWITCHES. 48-page catalog describes switch characteristics and method of ordering.—Daven Co., Livingston, N. J.

CIRCLE 319 ON READER-SERVICE CARD

ENGINEERED PLASTIC products of foamed and reinforced plastics with controlled properties are described in 4-page Bulletin 611.—Polystructures, Inc., 41 Montvale Ave., Stoneham, Mass.

CIRCLE 320 ON READER-SERVICE CARD



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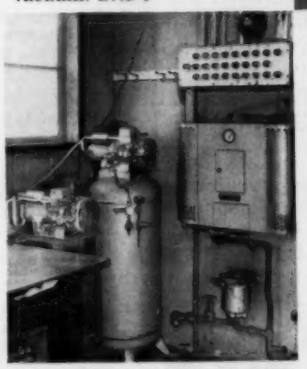

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TIMING MODULES. 5-page Bulletin PD-1016 describes Microminiature Timing Modules.—G-V Controls Inc., 101 Okner Parkway, Livingston, N. J.

CIRCLE 321 ON READER-SERVICE CARD

CABLE TRACER which traces up to ten conductors or pairs at one time without the need for buzzers, bells or a helper is described in new 4-page catalog CTC-5, Pyramid Instrument Corp., Lynbrook, N. J.

CIRCLE 322 ON READER-SERVICE CARD

INDICATOR, GYRO. 2-page Data Sheets 115-14 and 116-11 describe Flight-Director Altitude Indicator and Rate Gyro.—Lear Inc., Instrument Div., 110 Ionia Ave., N. W., Grand Rapids 2, Mich.

CIRCLE 323 ON READER-SERVICE CARD

MICROWAVE TUBES. 8-page short form catalog features advanced high power traveling-wave tubes.—Hughes Aircraft Co., Microwave Tube Div., 11105 Anza Ave., Los Angeles 45, Calif.

CIRCLE 324 ON READER-SERVICE CARD

ACCELEROMETERS. 2-page Bulletin T-105 describes 8 models of compression-type accelerometers.—Columbia Research Labs., MacDade Blvd. & Bullens Lane, Doodlyn, Pa.

CIRCLE 325 ON READER-SERVICE CARD

DELAY LINE. 2-page catalog sheet describes Type 192 Magnetostrictive Delay Line.—Deltime Inc., 608 Fayette Ave., Mamaroneck, N. Y.

CIRCLE 326 ON READER-SERVICE CARD

GASKETS. 2-pages of military standards detail Teflon gaskets, packing backup and packing retainer rings.—Tetrafluor, Inc., 343 Hindry Ave., Inglewood, Calif.

CIRCLE 327 ON READER-SERVICE CARD

ELAPSED TIME INDICATORS. 2-page data sheet describes ¾-oz. microminiature ETI's.—A. W. Haydon Co., 230 N. Elm St., Waterbury, Conn.

CIRCLE 328 ON READER-SERVICE CARD

ANTENNAS. 12-page brochure describes antenna and microwave products.—AEL, Inc., 121 N. 7 St., Phila. 6, Pa.

CIRCLE 329 ON READER-SERVICE CARD

POTENTIOMETERS. 28-page catalog details ½" to 5" dia potentiometers.—Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

CIRCLE 330 ON READER-SERVICE CARD

BOLOMETERS. 4-page Bulletin 600 details bolometers, thermistors and mounts.—PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y.

CIRCLE 331 ON READER-SERVICE CARD

POWER SYSTEMS. 8-page catalog describes dc-to-dc, dc-to-ac, and ac-to-dc power modules.—Victory Electronics, Inc., 50 Bond St., Westbury, L. I., N. Y.

CIRCLE 332 ON READER-SERVICE CARD

VOLTAGE SOURCE. 2-page bulletin describes Model VS-111 precision Voltage Source.—Electronic Development Corp., 423 W. Broadway, Boston 27, Mass.

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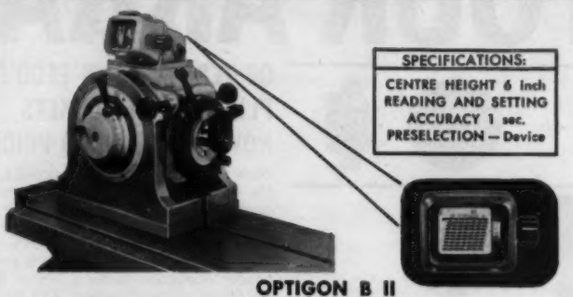

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MICROWAVE FREQUENCY REFERENCE TABLE cross-reference band code letters and corresponding microwave frequencies.—Applied Dynamics Div., Atlee Corp., 330 Bear Hill Rd., Waltham, Mass.

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OSCILLATOR, AMPLIFIR. Two data sheets describe 1000-Cycle Frequency Standard Oscillator and Audio Frequency Amplifier.—Lockheed Electronics Co., Avionics and Industrial Products Div., 6201 E. Randolph St., Los Angeles 22, Calif.

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SILICONE APPLICATIONS for aerospace industry are presented in 16-page Brochure CDS-276.—Silicone Products Dept., General Electric, Waterford, N. Y.

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RELIABILITY. 28-page booklet examines one corporation's compliance with AGREE (Advisory Group on Reliability of Electronic Equipment.)—Hoffman Electronics Corp., Military Products Div., 3740 S. Grand Ave., Los Angeles 7, Calif.

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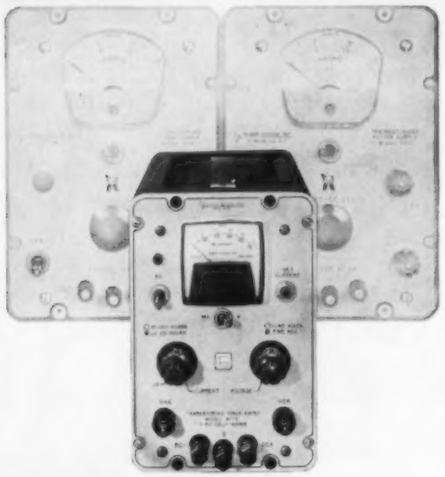

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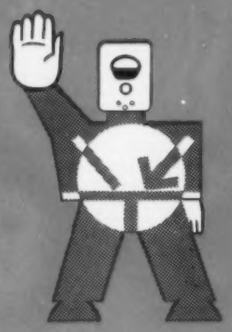

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MAY 1-4—Seventh Annual Aero Space Instrumentation Symposium, Sponsored by the ISA, North Texas Section, in Dallas, Texas. Write Walter Gabriel, Program Chairman, P. O. Box 321, Arlington, Texas.

MAY 4-5—Second National Symposium on Human Factors in Electronics, Marriott-Twin Bridges Motor Hotel, Arlington, Va., Sponsored by the PGHFE-IRE. Write Chas. DeVore 3226 16th St., N. W., Washington 10, D. C.

MAY 9-11—Western Joint Computer Conference, Ambassador Hotel, Los Angeles, Calif., Sponsored by PGEC-IRE, AIEE and ACM. Write Prof. Cornelius Leondes, Dept of E. E., Univ. of Calif. at L. A., 405 Hilgard Ave., Los Angeles 24, Calif.

MAY 15-17—Microwave Theory & Techniques National Symposium at Sheraton Park Hotel, Washington, D. C. Sponsored by PGMTT-IRE. Write Gustave Shapiro, Nat. Bur. of Stds., Washington, D. C.

JUNE 12-13—Third Annual Symposium on Radio Frequency Interference, Sheraton Park Hotel, Washington, D. C. Sponsored by PGRFJ. Write Ed. Mischler, Nat. Engineering Service, 1108 16th St., N. W., Washington, D. C.